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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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NORTHWEST MEDICAL ISOTOPES SUBCOMMITTEE

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OPEN SESSION

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MONDAY

JUNE 19, 2017

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Margaret Chu, Chairman, presiding.

COMMITTEE MEMBERS:

MARGARET CHU, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR., Member

WALTER L. KIRCHNER, Member

JOSE MARCH-LEUBA, Member

DANA A. POWERS, Member

JOY REMPE, Member

PETER RICCARDELLA, Member*

GORDON R. SKILLMAN, Member

JOHN W. STETKAR, Member

MATT W. SUNSERI, Member

DESIGNATED FEDERAL OFFICIAL:

KATHY WEAVER

MIKE SNODDERLY

ALSO PRESENT:

ALEXANDER ADAMS, JR., NRR

MICHAEL BALAZIK, NRR

GREGORY BOWMAN, NRR

MICHAEL CORUM, NWMI

GARY DUNFORD, NWMI

CAROLYN HAASS, NWMI

ENVER ODAR, SC&A*

STEVEN REESE, NWMI

JIM SERVATIUS, Information Systems Laboratories, Inc.*

DAVID TIKTINSKY, NMSS

ANDREA D. VEIL, Executive Director, ACRS

*Present via telephone

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P-R-O-C-E-E-D-I-N-G-S

(8:30 a.m.)

CHAIRMAN CHU: Hi. This meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Northwest Medical Isotopes, NWMI Subcommittee.

I am Margaret Chu, Chairman of the Subcommittee. Members in attendance today are Ron Ballinger, Matt Sunseri, Gordon Skillman, Dana Powers, Dennis Bley, John Stetkar, Jose March-Leuba, Walt Kirchner, Charlie Brown, and Joy Rempe. ACRS Member Pete Riccardella will join us later on the bridge line.

The purpose of today's meeting is for the subcommittee to hear briefings from representatives of Northwest Medical Isotopes regarding their construction permit application for a radioisotope production facility in the City of Columbia, Missouri, for producing molybdenum-99.

We also expect to hear from the NRC Staff regarding their review of this application. Four chapters, namely Chapters 1, 2, 4, and 5, of the construction permit application, preliminary safety analysis report, and the associated NRC Staff safety validation reports are scheduled for discussion today as noted in the agenda.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Rules for this conduct and participation in the meeting have been published in the Federal Register as part of the notice of this meeting.

Kathy Weaver is the designated federal official for this meeting. Please note that portions of this afternoon's session will be closed to the public to protect information proprietary to NWMI or its vendors, as shown on the agenda.

A transcript of the meeting is being kept. Therefore, it is a requested that all speakers first identify themselves and speak with sufficient clarity and volumes so that they can be readily heard.

During the open portion of this meeting a public bridge line will be open on mute so that those individuals may listen in. At the appropriate time later in the meeting we'll have an opportunity for public comment from the bridge line and for members of the public in attendance.

During the closed portion of this meeting the public bridge line will be closed. However, at the request of NRC Staff we will have a phone line open for some of the NRC contractors who contributed to the

NRC Staff review.

During this period please keep the phone lines on mute so as not to disrupt our meeting. Now we will proceed with the meeting and then I will call upon Gregory Bowman, Acting Deputy Director of the Division of Policy and Rulemaking, to open the presentation today.

MR. BOWMAN: Thank you, Dr. Chu. So my name is Greg Bowman. As you mentioned I am the Acting Deputy Director of the Division of Policy and Rulemaking in the Office of Nuclear Reactor Regulation.

Our Division and the Division of Fuel Cycle Safety, Safeguards, and Environmental Review in the Office of Nuclear Material Safety and Safeguards, along with our technical contractor, Information Systems Laboratories, are pleased to be here today to conduct a briefing for you on the Staff's safety review of the Northwest Medical Isotopes construction permit application.

In addition to the NRC staff, Carolyn Haass and Steve Reese, along with other staff from Northwest, are here today to present information on their application.

The NRC Staff received a construction permit application for a medical radioisotope production facility from Northwest Medical Isotopes in the Summer of 2015.

This is the second application received by the NRC to construct a medical isotope production facility. As most of the committee members are aware, the NRC issued a construction permit to SHINE Medical Technologies, Incorporated, in February 2016.

Similar to SHINE, Northwest Medical Isotopes is proposing to produce an important isotope, molybdenum-99. This isotope decays to technetium-99 metastable, which is used in numerous medical applications worldwide.

We appreciate the opportunity to present to you today on the results of our safety evaluation of the Northwest Medical Isotopes application and we look forward to continued engagement with the ACRS over the course of our review.

We also appreciate the ACRS and its staff for working with us to develop an efficient review schedule. With that, I will turn things over to Carolyn to begin the presentation.

MS. HAASS: Hi, I am Carolyn Haass. I am the Chief Operating Officer of Northwest Medical Isotopes and the first thing I want to do is I want to introduce all of the team members here and I want to give a quick bio of each of them.

But first I will let you know I have over 30 years of experience in nuclear and chemical engineering, both in the Department of Energy and the private sector, and, obviously, now with Northwest Medical Isotopes.

I don't want to focus on me, actually I want to focus on everyone else. Steve Reese, he is the Irradiation Services Director for Northwest Medical Isotopes, as well as he is the Director of the Oregon State University Radiation Center.

He has a Ph.D. in Radiological Science from Colorado State University. He is the licensee for the Mark II trigger reactor for Oregon State University.

He is on the Executive Committee for TRTR. He is also on the working group for ANSI/ANS 1511, which is RAD protection, and 1516, which is emergency preparedness.

He is also a certified health physicist and a senior reactor operator. So he is very significant to our company and making us go forward and understanding, you know, because we do deal with radiation.

Gary Dunford, who is to my far right, he has over 38 years of experience, and he is the Process

Lead for Northwest Medical Isotopes. He has a company that is based out of Richland, Washington, and back about 15 years ago he decided to start this company and he brought in all, and I don't mean to rude here, but all the old-timers that came from the Hanford site, especially PUREX.

And so they are bringing over 200 years of actual, you know, uranium experience, and not only do they have PUREX, but they are very heavily involved in Hanford Works site, you know, especially the waste treatment plant there, so they have lots of experience there.

Mike Corum, to my right, he is with Atkins Global and he is the VP of Commercial Nuclear and Specialty Engineering, and one of the things that Atkins brings is about over 500 years in specialty engineering for nuclear, you know, such as core physics, thermal hydraulics, shielding, criticality, integrated safety analysis, anything you can think of, you know, they are bringing to us.

But some of the other key things that they are bringing, and Mike especially, is he has been the Senior Advisor on the Fire Hazards Analysis for all the units at Fukushima.

They have also been providing extensive

resources to the Westinghouse Columbia Fuel Fabrication Facility for the scrubber incident as well as lots and lots of other projects that, you know, we are able to bring all that experience and lessons learned to Northwest Medical Isotopes.

So I just wanted to let everyone --

MEMBER POWERS: I can't help but respond and ask a couple of questions. You have a lot of people on your staff that, of diffuse interests, that is they are pulled in a lot of different ways.

Mr. Reese especially seems to have lots and lots of obligations. You have a lot of background from previous facilities. I can't help but note the last time I did a safety review for PUREX the previous year they had 2000 plumbing errors, that is moving liquids from either the wrong place to the wrong place or in the wrong way or something like that, 2000 of them in one year.

So do you have the focus that is going to allow you to bring this facility to successful fruition with all this dispersion of interest?

MS. HAASS: When I look at Gary and his company I have dedicated staff that work for Northwest Medical Isotopes as well as Atkins. I understand that Steve has a dual role here, but he has been part of

Northwest Medical Isotopes from the beginning just like I have, and that was back in 2009.

Oregon State University is actually a founder of Northwest Medical Isotopes and they are very dedicated in making this work and I don't believe that we have dispersed interests, because everyone here is 100 percent on this project except for Steve and we have dedicated staff.

MEMBER POWERS: Well, of course, religious faith is an individual prerogative.

MS. HAASS: So if you go to Page 3 of the presentation --

MEMBER REMPE: Excuse me.

MS. HAASS: Oh.

MEMBER REMPE: I had questions about Page 2. Could we look at it briefly?

MS. HAASS: That's just a cover page.

MEMBER REMPE: Well, actually, the next, the page that has the diagram of the facility. That page is Page 1 right now, the next page is --

MS. HAASS: Oh, okay. Oh, sorry.

MEMBER STETKAR: Carolyn, if you say anything you have to have your mic on.

(Off microphone comments.)

MEMBER STETKAR: No, no, no --

MS. HAASS: No, I understand, I was just trying to figure out --

MEMBER STETKAR: Don't move that because that is the transcriber's recorder, so don't pick that up, please.

MS. HAASS: Okay. Joy, sorry.

MEMBER REMPE: So is that Page 2 or Page 3 here.

MS. HAASS: That's Page 2.

MEMBER REMPE: Okay, good, we're on the same page then, okay. When I was reading through the material to prepare for this meeting the word "target" seems to have different meanings.

Could you define what exactly the target is? Is it the widget you ship to Oregon State University's test reactor or is it the stuff inside the widget that you are going to ship to there or to the MURR?

MR. REESE: It's what gets shipped.

MEMBER REMPE: Okay.

MR. REESE: That's correct.

MEMBER REMPE: That's good, and then I will have some questions later on. And then secondly, you've got two, maybe three test reactors, and if you get into some of the details sometimes there might be duplicate lines and is your intent to go and say, okay, we're going to fabricate and we're going to process all the targets from MURR, are you going to have both kinds of targets running through the system at the same time, or how are you going to do this?

MR. REESE: Well, it will be in batch mode such that we don't really expect them to come from the same, or two different reactors for the same batch.

It's really oriented towards either a batch from one facility or a batch for another facility.

MEMBER REMPE: So you won't have MURR targets and OSU targets coming in at the same week or month or something? You're going to process them all and then you say, okay, let's switch and do the others? Is it sequential or simultaneous is what I am trying to ask?

MR. REESE: It's sequential into the facility. Obviously, once it gets past dissolution phase and you move towards, you know, you pull off the moly and you take the fission products and put it in the hot cell, at that point everything gets mixed.

MEMBER REMPE: Okay. So I might have some questions later on and some of it will be in the closed, but it is going to sort of be simultaneous is what I am kind of hearing?

MR. REESE: Uh --

MEMBER REMPE: Well, so it --

MR. REESE: Past the initial dissolution, yes, you are absolutely correct.

MEMBER REMPE: Okay.

MS. HAASS: The other key thing is it is the same target design for any reactor.

MEMBER REMPE: That's where I am having some confusion, because I would think the widgets that you stick in the other reactors would be somewhat different in geometry, but you are telling me they are exactly the same whether it goes to MURR, the undefined reactor, or because some of them may have plate fuels, some of them may not have plate fuels, but it's in an irradiation position that they can accommodate the identical same geometric design?

MR. REESE: You are precisely correct.

MEMBER REMPE: Okay. That wasn't clear to me from what I was reading I guess. Thank you.

MS. HAASS: Page 3. The reason I have this slide here is I am trying to focus here that what you are seeing where the circle is where it says "Target Processing Facility," that's what we are really trying to do.

That is the whole point of Northwest

Medical Isotopes is that we are going in and we are going to go make molybdenum-99. Now you do see some arrows that go around the fabricated targets, you know, where we irradiate, and that is to show that we have a network of university reactors that are going to go support us in the irradiation and we do that because, you know, we want to make sure there is a reliable supply of moly.

And so we understand that the University of Missouri research reactor is our primary reactor and then Oregon State University, and a third reactor, which is very similar to Oregon State University, will support us in the effort.

We all know that MURR is a very dedicated reactor. We know that they are very reliable, but we do know that they go down every once in a while for maintenance or other items like that.

So this site is just to show you we are focusing on target processing. We do not make the generators, we are not a nuclear pharmacy, and we are obviously not the hospital or clinic that actually uses the technetium kits, you know, for the end user.

So the next page shows, Page 4 shows that, you know, all I am trying to show here is that we do have a network of university reactors and you are seeing that Oregon State obviously is in Oregon and MURR is in Columbia, Missouri, and then our facility is about five miles from the MURR reactor.

MEMBER REMPE: So, again, I have questions. There is clearly a third one coming on from what I have read, but the licensing information you have submitted in your construction permit acknowledges the fact that there is different types of the isotopes you are going to be getting in because you have different irradiation powers you are irradiating at, there is different decay times.

All right, every time you add another reactor are you going to do a revision to your licensing information for this facility?

MS. HAASS: The license amendment for any reactor, that license amendment the reactor has to go do.

MEMBER REMPE: The reactor does, but, also, you guys have to accommodate the fact that you've got different stuff coming in with your target.

Every time you would have a different reactor you would have like, what is it, 30, and sometimes it's eight and sometimes it's 12, but I am reading from the MURR, and that's another question I have of when you are finally going to have everything consistently updated.

But are you going to do a revision to your licensing amendment request when you finally get, you know, a third reactor or a fourth reactor every time to figure out if you've got the right solutions that you -- I am not a chemist, so I will probably say these words wrong, but, you know --

MR. REESE: No worries.

MEMBER REMPE: -- it seems like you have to do something to acknowledge that you have considered that it may have different properties when it comes in.

MR. REESE: Yes, that's correct. I mean all of these reactors will have different spectrums and they all have different powers and different fluxes.

MEMBER REMPE: Yes.

MR. REESE: So presumably what we would do is we would evaluate it and see if it is essentially bounded by OSU and bounded by MURR, and if it is it would make, certainly, a license amendment to this facility much easier.

MEMBER REMPE: But you will do a license amendment every time you put on another reactor?

MR. REESE: We likely will --

MEMBER REMPE: Okay.

MR. REESE: -- I couldn't see us doing that under 50.59.

MEMBER REMPE: Okay, thanks.

MS. HAASS: Page 5, Facility Siting. As I stated earlier, and I know Margaret did as well, we are going to be -- Our location is in Columbia, Missouri.

We are actually on property that is owned by the University of Missouri system. It is called Discovery Ridge Research Park. It is a 550-acre research park.

There is two other companies that are currently there, an analytical laboratory and then another isotope-type company.

Our site is 7-1/2 acres and what you see on the right side of this slide is you kind of see a pictorial or a cartoon that shows where our radioisotope facility is going to be located on Lot 15 where the admin building is, and then in the upper left-hand corner you are seeing the outbuildings, such as the emergency diesel generator, there is a waste management building, those types of items.

Page 6, Licensing Approach. We have submitted this application to obtain a license for a production facility under 10 CFR 50, Domestic Licensing of Production and Utilization Facilities, and our proposed action is is that, you know, we'd like to get this license and get authorized to construct and operate this facility.

This facility will receive irradiated low-enriched uranium targets from the University network reactors. We are going to process the irradiated low-enriched uranium, which includes dissolution, recovery, and purification of moly.

We are going to recover and recycle the low-enriched uranium. We are going to treat and package waste and we are also going to provide analytical laboratory and other support services.

And we are going to go through this in more detail this afternoon.

MEMBER SKILLMAN: Let me ask this question, please, Carolyn.

MS. HAASS: Yes.

MEMBER SKILLMAN: You make clear through your documentation and the Staff makes it clear in their documentation that there is a clear Part 50 and part of this application of Part 70.

And my question for Chapter 1 is, to the extent that you can describe it here, is there friction or complication in the integration between the Part 50 actions and processes and the Part 70 actions and processes? It's an integration question.

MS. HAASS: Right.

MEMBER SKILLMAN: How does this fit together?

MS. HAASS: We don't believe there is, obviously, a friction or an integration problem between these two. I mean we have had a lot of discussions with the NRC Staff on this on how we are going to go an integrate this.

And, you know, originally we were hoping to get one license under Part 50 and then, you know, get a Part 70 and 30 license and there was a lot of discussion, but the NRC Staff would like to see that these licenses will be obtained separately.

We will have one application. We'll show a very, very extensive crosswalk on how everything is covered, both with Part 50 and Part 70, and that Part 70 will be reviewed when we submit our operating license application.

That was one of the other issues in having both a 50 and 70. You know, 70 doesn't require a construction permit application but Part 50 does and, you know, how you go about submitting those and how they get reviewed.

And I know that the NRC is going to go

through this in more, you know, in much more detail in their discussion.

MEMBER SKILLMAN: You mentioned that you have had a lot of discussion about this, has the discussion been around the complexity of having two or the integration of the two?

MS. HAASS: Yes, I would say both.

MEMBER SKILLMAN: And, really, we're going to hear more about this this afternoon?

MS. HAASS: We will, yes. Yes, sir.

MEMBER SKILLMAN: Thank you. Okay.

MS. HAASS: Page 7. This is actually just going into what Gordon was asking is that also in relation to our Part 50 application we will also be getting a Part 70 so we can receive, possess, use, and, you know, deal with special nuclear material, which means that we would be receiving low-enriched uranium from the Department of Energy and we would also be producing our target materials and fabrication of the targets themselves.

And on the very last bullet, we understand that, you know, every university reactor that is going to be part of this network they'll have to get their own license amendments, separate from ours, and we also know that there is a cask that we got to go do license amendment on, which will actually transport the irradiated targets from the reactors to the production facility.

MEMBER SKILLMAN: Will there be just and only one cask?

MS. HAASS: No. There is many more, but they are already licensed for what we need them to do. Like the ES-3100, that will be used to transport the low-enriched uranium from the Y-12 complex to our facility, that's already used.

We can use that same cask for our fabricated targets to send to the university, so that's already contained within that, but it's really the cask that is used for the irradiated targets that we'll have to go in and do some additional analysis, you now, thermal hydraulics, those types of things, heat lift.

MEMBER SKILLMAN: How many transport casks will you ultimately have in service?

MS. HAASS: Total for any type of cask?

MEMBER SKILLMAN: Yes.

MS. HAASS: Well --

MEMBER SKILLMAN: One, five, ten?

MS. HAASS: There is various casks as I said, you know, the ES-3100, you have for the irradiated targets. You also have a cask that will transport the molybdate solution that is produced, and then you will have casks for waste management.

And we'll go into more detail, like how many that we would have in our facility at a time, how long they have to decay, those types of things, this afternoon.

The MIDUS Container, which ships the molybdate solution, depending on what the request is, you know, how much supply is needed will depend how many, you know, containers you could have in your facility at one time.

There is some business-sensitive information in there I can't talk about.

MEMBER SKILLMAN: Okay, thank you.

CHAIRMAN CHU: A related question. So at the end during the operating license approval from NRC they will look at all of the casks that have been licensed as a part of the condition?

MS. HAASS: Well, any cask that we bring into the facility we obviously have to know that it's licensed appropriately for that operation, and so I am assuming that the NRC Staff would come in and make sure that we are working within that COC.

CHAIRMAN CHU: Okay, thank you.

MS. HAASS: Page 8. The primary

assumptions for our facility is, you know, the RPF is going to, we're going to fabricate targets, we're going to produce moly, and we are going to recycle and recover uranium, very big picture.

We are going to use a fission-based method, which is currently the gold standard for producing moly. That's what people use around the world.

Now there is a lot of technologies out there that people are, you know, right now doing R&D and, you know, and, you know, in the future there could be, you know, neutron capture or other types of moly production, but we are doing a fission-based method.

Our nominal --

MEMBER KIRCHNER: Could I interject something? You used "gold standard." I think what you mean by that is producing the materials with LEU, less than 20 percent enrichment.

MS. HAASS: Gold standard just means it is the standard that everyone is -- It's the method that everyone uses today.

MEMBER KIRCHNER: No --

MEMBER POWERS: So it could equally be stated that the old and crude geriatric method.

MEMBER KIRCHNER: Yes.

MS. HAASS: Okay.

(Laughter.)

MS. HAASS: I think that's a great way to say it.

MEMBER KIRCHNER: No, I bring this point up because it was quite a political issue several years ago, a decade now, since EPAct, that's the Energy Policy Act of 2005, and there was quite an extensive section in that Act about converting to low-enrichment targets.

MS. HAASS: You are exactly correct.

MEMBER KIRCHNER: So I would be careful how you throw the gold standard issue around.

MS. HAASS: Well, I -- Okay, so it's the gold standard using low-enriched uranium. If you go back to the American Medical Isotope Production Act of 2012, which was actually signed into law on January 3, 2013, odd little thing I know there, that actually states several things and one of them is that you have to, you know, they are trying to get the world, not just the, you know, domestic production, to convert from high-enriched uranium to low-enriched uranium.

Also within that Act that is where the Department of Energy supports this and, you know, for the uranium lease take back, you know, how we would get that low-enriched uranium.

And so our facility was never, it was never going to be developed to use high-enriched uranium. Another --

CHAIRMAN CHU: Let me just try to rephrase my understanding of your method versus the old, methods in the past 40 years.

In the past until now Europe and everywhere else they use HEU. You guys use LEU. It's because of the political push. Secondly, all these years all these facilities all over the world they have a problem with their waste.

They accumulate a huge amount of liquid waste that contain HEU and what you guys are doing is to recycle and recover the uranium using your 500 years of PUREX experience. Am I correct basically?

MS. HAASS: You are correct.

CHAIRMAN CHU: There is a big difference.

MS. HAASS: You are exactly correct. I mean I will tell you that, you know, there have been other potential producers out there, without naming, I mean in a closed session I could tell you who they are, but they actually went through the business model, and when you go through the business model and if you can't recycle and recover the uranium you can't pencil the business out.

It's too expensive, you can't make money, you wouldn't go do it. I mean it just doesn't make sense.

The next assumption, and I think as I have already said is we are going to have a network of university reactors and we are going to use the same target design for all reactors.

Steve will be able to go through in more detail what that means for each of the reactors using the same target design.

That target design we also have, we have already obtained our intellectual property in the U.S., Australia, Russia, South Africa, Korea, and we are in the final stages in India, Europe, and China.

It's a very unique target. We will go through it in detail this afternoon so you can see what it's all about, but I will tell you it is Steve and Oregon State's intellectual property which we have full rights to.

So all fission product releases will comply with environmental release criteria. We are only going to generate Class A, B, and C waste. No greater than Class C waste will be generated.

MEMBER SKILLMAN: On your first carat there, nominal capacity 3500 6-day curie surge of 1500, does that mean that your max nominal, or your max for

6-day is 5000 curies, is it 3500 plus 1500?

MS. HAASS: Correct, if we needed to do the surge capacity.

MEMBER SKILLMAN: Okay. Now maybe I am jumping too far into Chapter 5, and this is the limitation of targets per week, is your max at 5000 based on heat removal capability of your systems? That isn't the limiting attribute for this?

MS. HAASS: No.

MR. REESE: No, that isn't the issue.

MEMBER SKILLMAN: Not an issue?

MR. REESE: No.

MEMBER SKILLMAN: Thank you.

MR. REESE: We'll catch up later. Thanks.

MS. HAASS: Page 9. So Page 9 shows our proposed schedule. We are hoping to start construction in the first quarter of 2018, earlier if we can, depending on approvals.

We feel that it's about an 18- to 20-month construction period, but we think right around, you know, at the end of the second quarter of 2019 with facility startup in the third quarter of 2019 and hot commissioning and commercial operations will go through, will start in the fourth quarter of 2019, and then in the first quarter of 2020 we start our qualification runs.

There are some FDA things, qualification runs we have to do. Each reactor will have to do them. One of the things I didn't note is that when I say we have a network of university reactors, we are going to be, we are not going to bring all reactors on at once.

We are going to be brining MURR on, go do those validation runs, then we'll be bringing Oregon State University on, and then the third reactor. So they all don't come on at once.

MEMBER SKILLMAN: A question, please.

MS. HAASS: Yes?

MEMBER SKILLMAN: Imagine that we are in 2049 and this facility has been wildly successful, it has become the icon for how this business is done, what considerations are you giving in 2017 to the potential to extend the life? Equally, what considerations are you giving right now to making sure that the decommissioning will be smooth and easy?

MS. HAASS: When we design a facility we look at it from a constructability and an operability perspective, but the third, you know, leg to that chair is you have to look at it from a decommissioning perspective, and if we don't look at it, you know, it would be very expensive to go do.

I mean so we have to go develop this decommissioning budget, so we have to understand what that means and we have to figure out in the design how we would do that simply.

Do you want to add anything?

MR. REESE: No, I think in this case, maybe we could talk about this more later, but I think the same issues that drive operational concerns also drive decommissioning concerns, or to a large extent do.

So when we talk about how we might tear this facility apart, those are the same kinds of questions we might want to ask if we want to repair an existing component of the facility to make that as easy as possible.

So we do, we think about it, but we find that when we do think about it it melds pretty well with how we want to handle things operationally. In other words, having things on skids, component, I hesitate to use the word plug and play, but that's simplified and it's easy to take components out and place components as possible.

When you talk about life extension those are the kinds of, you know, typically we are concerned with the material behavior over the course of the operating license and how we could extend that.

MS. HAASS: One of the other things we have done is we have visited several other moly production facilities, you know, and have gotten lessons learned from them on what works and doesn't, both from a constructability, operability, and then be forward looking on the decommissioning, so we are not leaving that out.

Also, when decommissioning says 2050, we hope that that facility can have a life, you know, an extension beyond that, but, you know, we are looking at this purely from a license perspective, but our facility is being designed, you know, more for a 40-year type operation, but as Steve said, when you make it simplistic and you put things on skids and you can go in and replace those things, just like you would do typically with pumps or whatever, you know, when they go out, we would be able to extend the life of this.

MEMBER SKILLMAN: Yes. My question wasn't intended to be tricky or to be clever, I just know from firsthand experience if you design it so that it can be --

MS. HAASS: We agree.

MEMBER SKILLMAN: -- taken apart intelligently --

MS. HAASS: Agree.

MEMBER SKILLMAN: -- you increase the level of the safety for the workers, you decrease the dose rate --

MR. REESE: Absolutely.

MEMBER SKILLMAN: -- and integrated dose to those workers and you just save yourself one heck of a lot of work for the generations to come if you invest that thinking now.

MS. HAASS: We agree. We completely agree with you and that's why it's very, very important, and the company is not represented here, but we have gotten our construction company involved in the design, and that's, you know, part of, you know, from a constructability perspective.

We get operational people involved from an operation perspective and the construction company also has decommissioning expertise to go in and evaluate that as well.

MEMBER SKILLMAN: Okay, thank you.

MS. HAASS: Yes.

MEMBER SKILLMAN: Who is, since you brought it up, who is the AE and the constructor?

MS. HAASS: So the AE, we have a dual role from an AE perspective. We have Atkins Global and we have Merrick & Company that is out of Denver.

Atkins Global, they will be based out of Charlotte, North Carolina, and Merrick is based out of Denver, and, you know, we do a lot of things, you know, we just integrate through, you know, the network and things are just done in real time and they are able to talk to each other and communicate.

So I will say that Atkins actually is the project manager for the overall design and then McCarthy Construction out of St. Louis is our, well, McCarthy Builders, I apologize, they are our construction contractor.

They are also doing our pre-construction work right now, which means that, you know, we are looking at labor, we're looking at all the vendors that we've got to bring onboard, you know, already getting all that work done in advance of turning any dirt once we get approval.

MEMBER SKILLMAN: Who gets fired if this doesn't come off properly?

MS. HAASS: It's me.

MEMBER SKILLMAN: You got a lot of lines of accountability that you just described.

MS. HAASS: I agree. It would be me and the other officer of the company.

MEMBER SKILLMAN: Okay.

MEMBER REMPE: So in looking at the information for the site there is some information with respect to soil liquefaction that is not done. The Staff SE said it was supposed to be submitted by the, or done by the first quarter of 2017, which we are long past.

I believe later today you are going to tell us that it's going to come with the operating permit, and I am just curious if that's kind of taking the cart before the horse in Missouri terms?

I am from Missouri, but, anyway, I just was curious about is that kind of risky to go ahead and start pouring concrete ahead of time?

MS. HAASS: We are not going to be pouring concrete without our final geotechnical work being completed.

MEMBER REMPE: Okay.

MS. HAASS: Our final design can't even be finalized until then.

MEMBER REMPE: Okay. So we are passed the first quarter of 2017, the Staff SE said it would be submitted then. You have all of it done? You are planning to do it?

MS. HAASS: We do not have it completed

yet, we are planning to do it. We are waiting for a final approval from the university system itself.

MEMBER REMPE: Okay. So you've --

MS. HAASS: To go in and do it.

MEMBER REMPE: When is the -- You'll do it before you break ground is your plan?

MS. HAASS: Oh, gosh, yes.

MEMBER REMPE: Okay.

MS. HAASS: We have to do it before we can even -- We have started our final design. We have a very good idea, and I may have to have Mike jump in here, but if you start looking at it from, you know, a seismic perspective or any external hazards --

MEMBER REMPE: Yes.

MS. HAASS: -- you know, this geotechnical work is very important and we understand that and Atkins is actually doing all of the external hazards, especially the seismic modeling for us.

MR. CORUM: Yes, I'll just add that the soil liquefaction, you know, will be an issue that we are going to look at, particularly with the clay-type soils that retain moisture and then over time the moisture leaves and --

(Simultaneous speaking.)

MEMBER REMPE: Well, I believe you'll look at it, but I am just curious about schedule and how it fits in with the Staff granting a construction permit.

Are they going to have that like as an action item that -- I didn't see it in my, or maybe I missed it in what I was reviewing, but is it a condition before you can start construction or how does this work?

MS. HAASS: I have no idea.

MEMBER REMPE: Okay.

(Simultaneous speaking.)

MEMBER REMPE: I guess we will ask the Staff about that, okay.

MS. HAASS: Okay.

MEMBER SKILLMAN: I had that same question, I was going to wait until Chapter 2 because there is the statement that we have that the liquefaction potential issue will be discussed and the report is due first quarter of 2017, just like Joy said, but in Chapter 1 and 2 you discuss sinkholes to some relative expanse in discussion, and your nearest sinkhole is 0.7 miles away, which is really not that far away.

So I would think this whole issue of your geo report before you turn a first soil of dirt is super critical.

MS. HAASS: We completely agree.

MEMBER SKILLMAN: So maybe we'll talk about some of this in Chapter 2. Okay.

MS. HAASS: All right, I am getting pushed to go forward. Page 10 --

CHAIRMAN CHU: Let me say something about schedule. We are kind of running behind, but this is a very important chapter and I would like to have people run through this whole thing at a reasonable pace rather than rush it through, and then I will adjust the schedule accordingly, okay. Thank you.

MS. HAASS: Page 10, our operating characteristics, or this is really our process flow diagram. What we do, as I have already told you, we have five, there is five major parts to our business model.

One is target fabrication, which includes, you know, producing the LEU target material itself, which we will go into detail this afternoon, the encapsulation of it into the target itself, and then the target packaging, then it would get shipped to one of the reactors where it would be irradiated.

After irradiation, which is about 160 hours, I can't remember exactly the number it is, but 6-1/2 days, six to 6-1/2 days, it will then be pulled out of the reactor, it actually will sit in the pool for about 24 hours before we can even put it into a cask because it will be too hot.

We are still finalizing those. I think that we have come up with some new numbers. We have done quite a bit of thermal hydraulic-type analyses and heat analyses for this.

Once we get that out of the reactor into the cask it is shipped to the radioisotope production facility where we go into, we receive it, we then disassemble the targets themselves, and then we dissolve the targets.

Once the targets are dissolved we go into the moly recovery and purification and then that solution is, that product solution is packaged and then it is sent to a generator manufacturer.

And, you know, there are three in the United States right now. One is Curium in St. Louis, the second is Lantheus in Billerica, Massachusetts, and then you have GE Healthcare, which their facility is in the Northeast, and I forget where off the top of my head.

That is the most critical thing we are doing, is making the moly. Then once we get that done on a weekly basis we will be going in, you know, we'll be doing uranium recovery and recycle.

That is not something that happens in a week. What I think you are going to hear this afternoon when Gary talks about it, to get to the point there are certain things that have to decay before we can use that material, especially because we want to do contact handled, and so there is quite a bit of decay --

MR. REESE: Lag storage.

MS. HAASS: Huh?

MR. REESE: Lag storage built in.

MS. HAASS: Yes, lag storage built in for decay. And so we will go into that in more detail. Page 11, the ventilation. Obviously, we will be going into all of this in a bit more detail this afternoon, but our ventilation system is divided into four zones with the airflow directed from the lowest to the highest potential for contamination.

We will be showing you some, you know, cute little graphics about, you know, which portions of our facility are a Zone 1, 2, 3, and 4, and how that flow will work.

Zone 1's ventilation system will be the initial confinement barrier, which, you know, includes the glove boxes, the vessels, the tanks, the piping, hot cells, and the Zone 1 exhaust system.

The biological shield, you know, will provide an integrated system of features that protect workers and the public from high dose radiation.

The primary function of the biological shield will be to reduce the radiation doses and accumulate doses in occupied areas to not exceed 10 CFR 20 or any of our ALARA guidelines.

Engineered safety features are both active, can be active or passive features designed to mitigate any consequences from accidents and to keep radiological exposures to workers and the public within the acceptable levels.

And I know that at our next meeting in July we will be going through all these engineered safety features for you.

The primary consequences resulting from operations at the RPF are, obviously, mostly radiological and I don't know how much detail you want to go into this --

MEMBER KIRCHNER: May I back you up a bit?

MS. HAASS: Yes.

MEMBER KIRCHNER: Just to the last bullet on the preceding slide. How are you approaching confinement? You consider it a general ESF, could you talk about the design criteria for it?

In other words, we're going to hear in Chapter 2 about some of your meteorological design considerations. I am just curious about the confinement as a barrier, for example, external missiles and such.

MR. DUNFORD: This is Gary Dunford. So two things, the missile, the exterior walls, are not the shielding walls of the facility.

So there is an external structure of the facility that is going to have to meet the natural phenomena loads that we'll talk about in Chapter 2 and the design criteria is then identified in Chapter 3, which will be in the next meeting.

The cells, the walls and the cells themselves, obviously, can feel the load from a seismic event, so they will have to be seismic qualified to withstand that.

From as far as the engineering safety features, there are a couple, obviously, that do stand outside. We do accredit the stack, which is part of the confinement system. At this time at least we are accrediting it.

We are still having some internal discussions about whether that's what we want to do in the long run. So that also would have to be housed to withstand the seismic and other natural phenomena events against it.

So overall in the design process it is part of the design inputs and the design criteria in Chapter 3 that it has to meet that, it has to meet whether it's the 100-year flood or the highs and the extreme temperatures and stuff, those are all part identified in Chapter 3.

MEMBER KIRCHNER: That's the next -- That's in July?

MEMBER MARCH-LEUBA: Yes.

MEMBER KIRCHNER: Okay, thank you.

MEMBER REMPE: Oh, I did have a question on the prior slide.

MS. HAASS: That one?

MEMBER REMPE: Yes, it's this question about eight versus 12 and we just got like an update to Chapters 1, 2, 4, and 5 last week and it's still some of the chapters have eight replaced with 12, some of them don't, and are you guys planning to consistently update that you are capable of handling 12 targets from MURR and are you going to do all the analysis to reflect that before this document is done and when will we see it?

MR. DUNFORD: So it's a little confusing, I agree with you 100 percent. There are a multiple bases in the design and in the process. So if you looked at what the load on the facility is from special nuclear materials you would say it's the 30 targets are the bounding conditions and the concerns because that has the most uranium in the system.

If you look at an individual batch size you will find that in the process and in the discussion MURR has a set batch size, and whether it's four, eight, or 12, it's the same material in play at the same time.

So it doesn't really change from the standpoint of what is going on individually, and, in particular, you know, at that time.

What we have evaluated in the accident analysis we will talk about in Chapter 13 is we have actually used an inventory of while eight MURR targets is the nominal processing, as we talked about earlier, if there was a need in the system to go up to the 5000 curies, 6-day curies, then what we have tried -- we looked into the facility and said, okay, can we handle another four targets that comes in three days later or sometime later from MURR in that week and processing it into the system and what does that do to the safety basis, what does that do the design basis, and as part of that evaluation we have told Carolyn, yes, we believe that the design and the process will support that.

So when we did the accident analysis we used 12 in bounding source term space, but if you actually look at the design basis for some of the stuff there is only eight targets in a batch or four targets in a batch that allowed the thing -- So there is actually built-in flexibility because it's number of batches as opposed to saying I am running them all at one time and, therefore, is it four, eight, or six, or 12, or 30.

So there is dual trains, there is different things that will accommodate the potential need of a system for moly in our design process. So that's why it's a little bit confusing.

We had a similar conversation with the NRC that would say, well, if you did -- it's our how many targets can we build in a week, a month, and all those numbers don't match up because they are built for the worst, the largest environmental impacts so we use the largest values, not necessarily the values that we would actually ever expect to be processed.

MEMBER REMPE: So I get the underlying gist that you are trying to be conservative, and that's also, this relates to my question about doing things sequentially versus simultaneously, because there is a bunch of different limits and I wouldn't even pretend that I can keep track of them right now, but there is this 30 from OSU and you'll process those and get them out of the building and then you take some from MURR, which might be eight or 12, but I mean there is a bunch of different limits in the building and you guys somehow or another are accounting for it, and if you have another reactor that is like the OSU one, which isn't clear all the way to Oregon, maybe it's Wisconsin or someplace closer to Missouri --

MR. DUNFORD: Right.

MEMBER REMPE: -- you are going to consider that, too, because of the decay time and you guys are carefully accommodating this, and I'd have more confidence that you are, because you've got this integrated safety analysis that is coming up in the future here, too, if you had things all, i's dotted and t's crossed, that you think you have carefully -- and every time the Staff checks it with the calculations they are going to say, yes, they've used the right number in their conservative analysis everywhere is what you are hoping.

MR. DUNFORD: Yes, that would the outcome we would love --

(Simultaneous speaking.)

MEMBER REMPE: Yes, you are correct. Yes, okay.

MEMBER SKILLMAN: I'd like to go back to Walt's, to Dr. Kirchner's question, please. Gary, you answered, and when you answered Walt you were really in Chapter 1 space, design of this facility.

He asked about confinement and you began to talk about exterior walls and interior walls. So I don't know if this is the right time for me to ask my question, but let me ask it, and you might say wait until Chapter 2.

Dana had talked about some of these geriatric rules, some of us remember Flip Wilson, all you can drink for a quarter, remember that, it's all you can drink for a quarter.

In your PSAR at 1321 you make this statement, this is your statement, or NWMI's statement, "Design will provide for adequate protection against natural phenomena with consideration of the most severe documented historical events for the site."

"With consideration for the most severe documented historical events for the site," that is on your Page 1-26. Does that mean, the highest wind we have seen here is the vector of 00 and it went 1.16

miles per hour, and, hence, that's the limit for this site, or does that mean we are going to use either Callaway's data or other data from standard meteorological tables and the highest wind velocity is 88 miles an hour, but at 00 we had one incident at this approximate site in Columbia, Missouri, at 106, so we're going to use 106?

So what I am wondering is if you are going to use the lowest common denominator here or if you are going to take a look at what would be appropriate design and construction data and supplement it with the worst incident at this proposed plot of land?

And I will have this same question for seismic, for probable maximum precipitation, for ground motion, for sliding and overturning, those very same features.

MR. DUNFORD: Correct.

MR. CORUM: Yes, we will do what you are saying. We are going to look at the facility design based on normal methodology that we normally do for seismic, high wind, and missiles, but then we are going to look at the worst historical accident or worst historical event to make sure that we are bounding for that particular site.

MS. HAASS: And in Callaway.

MR. CORUM: And we are going to, particularly for seismic, we are going to use the peak ground motion, or peak ground acceleration that they used at Callaway.

MEMBER SKILLMAN: Well, I saw that, but that leads to some other questions about what other similarities you might use for Callaway. It looks to me like it's 23 miles away, so it's a pretty good --

CHAIRMAN CHU: Yes, maybe we can wait until chapter --

MEMBER SKILLMAN: Chapter 2.

CHAIRMAN CHU: -- later chapters, too, so we can run through this portion.

MEMBER SKILLMAN: Okay. Okay, Margaret.

CHAIRMAN CHU: Thank you.

MEMBER SKILLMAN: So we're in Chapter, I understand, and all of that data is in PSAR Chapter 1, so that's why I asked the question to Gary.

MEMBER REMPE: Right, because --

MEMBER SKILLMAN: I'll wait until Chapter 2, that's fine.

MEMBER REMPE: Okay. Question, data, you are sending these targets to different university reactors, how will, you know, they are going to run it for a period of time and then they're going to ship it back, do they characterize their reactor well enough during each of these runs that you have confidence you are not going to get something that's been irradiated more or less?

I mean how much -- Do you even have confidence in the numbers that are going to -- I mean do they do a lead test assembly or something like that in the university reactors so you even have a good baseline for the temperatures, for example, that are, of these targets that are coming back and the inventory that is coming back?

MR. REESE: So, excuse me, if I could answer that. So to start off with we have a license amendment that was granted to Oregon State University for demonstration of targets and it is our intent to do exactly what you are describing.

So we are going to --

MEMBER REMPE: That reactor you've -- the fabricated one?

MR. REESE: Yes, after we fabricate it --

MEMBER REMPE: Okay.

MR. REESE: -- we're going to make sure we are getting the temperatures we think we are getting, we're going to check to see if we are getting the isotopes we think we are getting, we're going to check to see if the reactivity effects on the cores, what we think they are, all of those things.

I would expect that we would probably do it in the unnamed third reactor as well as part of their license amendment, but we wouldn't do that in terms of a separate demonstration.

So for the third reactor -- what I am planning is is that the major demonstration phase is going to happen at OSU and the third reactor, while we can talk about some preliminary steps that would be done prior to production, we would probably just issue, or one, sorry, submit one license application for production straight away.

MEMBER REMPE: Okay. So you'll do one at OSU but MURR, which is a much higher --

MR. REESE: Correct.

MEMBER REMPE: -- power reactor you'll do one there, too?

MR. REESE: Well, we're knee deep in the process of writing up a license amendment for that right now, and what I imagine is that, you know, the license amendment is going to talk about a safety basis for it, but we are going to have to do some lead elements and we are in discussions with the facility now about what that looks like.

So what kinds of -- I would imagine that -- We are not done flushing all of that out, but I imagine that they want to ask the same questions that I ask at my facilities.

MEMBER REMPE: Okay. Thank you.

MR. CORUM: I'm Mike Corum, and over the next several slides I'll be providing an overview of the safety analysis methodology. To begin we use the, chose the ISA methodology to perform the safety analysis for this facility. That started out with a preliminary hazards analysis and resulting in a large number of scenarios.

We did use a qualitative analysis to go through systematically and try to limit the number of scenarios that we could group together, and then analyze on a more deep dive type of analysis.

So once we had the accident sequences narrowed down, we did look at them from a quantitative analysis standpoint. We assigned items relied on for safety to mitigate or prevent the events that were going to challenge the performance criteria in 70.61.

We did use event trees in certain circumstances, and identified many measures to ensure that the IROFS were available and could perform their intended function when needed. And then the final part of the integrated safety analysis process will be to translate the items relied on for safety to technical specifications which will be, is the more traditional way of doing things in Part 50.

And on order to do that, we got an IROFS boundary definition document that we're creating. And this will serve as the basis for translation into the tech specs. So you can see what the ISA baseline documents include, typically everything that we do in the analysis phase.

And this is a living document which will exist during the full operation of the facility. So any changes that are, that will occur to the facility that could impact the safety basis will have to be re-analyzed, and the ISA updated. And subsequently, we'll have to do the 5059 process to see if the tech specs are violated and see if we have to come in for a new license on them.

We do have a specific safety related definition, and it is a classification that we apply to items that are relied on to remain functional during and after a postulated design basis event. And this is to ensure that you have integrity of the facility, the capability to shut down, and remain in a safe shutdown condition, the capability to meet the performance criteria in 70.61, and also the capability to meet the requirements of 10 CFR Part 20.

The categories that we have are safety related items relied on for safety, and these are identified through the accident analysis that are required to meet the performance criteria in 70.61.

Then we have a category for safety related non-items relied on for safety, and these are SSEs that provide reasonable assurance that the facility can be operated without any undue risk to the public or safety of the workers or the environment. And it includes the SSEs to meet the 10 CFR Part 20 requirements.

And then we have non-related, or non-safety related items which are SSEs that are related to production and delivery of the products and services that don't fall into the safety classifications but are necessary for the facility to continue operation.

This, I'm on Slide 16, I'm sorry. This is just an indication of the preliminary hazard analysis that we went through. So we did have a large number of accident sequences or accident scenarios to begin with. We did identify and categorize those down to about 140 accident sequences that we identified for additional evaluation, and of those we chose 75 of the accident sequences to do detailed quantitative risk analysis on.

To date we've got eight QRAs completed. That covers the 75 accidents, and we have one QRA that addresses specifically chemical accidents.

On Slide 17, we are also performing a shielding analysis for safety to the worker as well as the under accident conditions to still provide safety to the public and the environment.

Our source terms are calculated based on the radio nuclide inventory from all the different process, or all the different target irradiations. We've used scale and origin S to decay the stream, radio nuclide inventories and provide the photon source spectrum.

Our dose rates we use the ICRP 74 flux to dose conversion factors in rotational geometry. We used the Monte Carlo N-Particle computer code to evaluate the shielding, or the particle transport and the shielding requirements.

And we have completed a preliminary shield wall design which I think is on the order of four foot thick concrete. This of course challenged out shielding designers. It's a deep penetration problem.

You've got to use advanced variance reduction and have a very good elaborate source description. So very different variance reduction techniques were used to push the particles through the thick shield.

On the next slide, Slide 18, this gives an overview of the criticality analysis. Where possible we used passive design features. So we have a lot of geometry constraints, spacing considerations and, you know, anywhere where we had transitions from a safe geometry process to a non-safe geometry process, then we took those into consideration.

So we ended up with an MCNP. We used MCNP code also for this. For that, for criticality safety we did the extensive validation for choosing critical experiments that were close, as close as possible to the processes that we're dealing with in this facility.

We ended up with 96 critical safety experiments. And from that we defined the area of applicability that the criticality safety analyst then uses going forward to set his upper sub-critical limits. So -- go ahead.

MEMBER REMPE: In all of these analyses, the shielding analysis and the criticality analysis, there are times where I've seen things that say oh, we try to be conservative. But like, uncertainties were never carefully tried to quantify. So how much margin do you think you have when it's all said and done at the end of the day?

MR. CORUM: The way we calculate safety margin is to do a parameter study on the item that we're controlling. So if we have a parameter that we're controlling such as tank size, we'll do a sensitivity analysis to find out, you know, how much of the tank wall can we erode away and still remain under that sub-critical limit.

In a lot of cases, we've gone to the complete outer diameter of pipe. So from that standpoint, we've got a ton of safety margin there because unless you change out that pipe with a larger diameter, you're never going to go critical in that pipe or vessel.

And that's the main philosophy that we've tried to use throughout the design of the facility. Any vessels that we have in the process, we've tried to model them to the outer diameter so that there is no way, we're safe by geometry. And unless you change out that tank with a larger tank, you're not going to go critical.

Now there are certain circumstances where we can't do that, and we're going to have to rely on an administrative control. And when we do have administrative controls, even though we don't really like to have them in the process, but you know, a manual operation it's hard to avoid them.

So when you do have administrative controls, it's important to make sure that they're easy to understand, easy to follow, and that you train your operators well.

MEMBER REMPE: And do you know from the analysis you've done where you're most sensitive and you might have the least margin and you can identify this is the location where I think I need to pay the most attention, maybe put some extra instrumentation in to feel comfortable about things.

And as we go into the discussions on this topic, not even in this subcommittee meeting but later once you're ready to tell us about that and what you've done?

MR. CORUM: Sure. Do you want me to go into that?

MEMBER REMPE: You don't have to today because I know we're way over schedule.

MR. CORUM: Okay.

MEMBER REMPE: But at some point, that's kind of where I was wondering when I was looking through this.

CHAIRMAN CHU: Definitely the next meeting, I believe.

MEMBER REMPE: Which I probably won't make.

MEMBER SKILLMAN: Let me ask this to Michael because we're still in Chapter 1. In your PSAR, and it is on Page 1-36, PSAR makes this statement, "NWMI has and will continue to perform testing to validate the acceptable operating conditions for material and target solution compatibility at MER and DOE national labs prior to completion of the RPF construction."

What does validate the acceptable operating conditions mean relating to testing? I'm kind of hooking it, Michael, to your discussion here on critical analysis. I'm just wondering what testing's involved, and where. What do you mean by this statement? Who's testing what and where?

MS. HAASS: Well, we have several different RND programs that we are, we have either completed or we are in the process of doing. We've done 12 different tests at MER. We've with DUNU and low enriched uranium to understand, you know, so we've made the material, we've irradiated it, we've dissolved it, we've produced the molybdate solution that could go into a generator.

We're also doing a much larger test over in Europe right now which I would be more than happy to talk to you about this afternoon. And we can go into more details there. But it's going through the whole process.

MEMBER SKILLMAN: All right, thanks.

CHAIRMAN CHU: So Carolyn, so you have done testing on the real scale?

MS. HAASS: We've done testing at MER, and obviously they have tech specs that we have to work within. And so this wasn't a full scale test. But we believe from a scalability perspective, it is not an issue, and we can go into detail later.

CHAIRMAN CHU: What I'm saying, once you receive the irradiated target, okay, have you done the real test from in a hot cell disassembly and dissolve it at the real scale and --

MS. HAASS: Not for the prototypical, no not for a full target.

CHAIRMAN CHU: Not a full target.

MS. HAASS: Not yet.

CHAIRMAN CHU: Okay.

MS. HAASS: We're working on that, and we can talk a bit more about that this afternoon.

CHAIRMAN CHU: What about dissolution and ion exchange, all that?

MS. HAASS: We have done all of that at a certain scale. We're bumping it up to the next.

CHAIRMAN CHU: Okay, not full scale. Okay, thank you.

(Off microphone comments.)

MR. CORUM: On Slide number 19, we have used the applicable standards and guides and codes to guide us through the process of performing the design at the RPF. We've used, even though they don't show up in our control strategy completely, we've used a defense in depth design philosophy.

So in addition to the IROFs that we will define, we do have other controls in place that don't rise to the level of an IROF, but it is provided there for defense in depth.

MS. HAASS: This is Carolyn Haass again. Page 20, a bit, I wanted to talk a bit on comparison with similar facilities. And Gordon, it goes to your question. You know, the reason we established a network of university reactors to your radiator targets is because that's as I said, and maybe the term gold standard wasn't the right term to use, but that is what is mostly, that is how most molybd is produced worldwide is you take either an HEU or an LEU target, and obviously we're doing LEU, and you irradiate it.

And then you know, once you get done irradiating, you go process this. Our facility is a conventional design. It's a similar design to other nuclear facilities. And yes, we understand all facilities have issues and you go resolve them.

We're taking those lessons learned. But dissolution of this material is not that difficult. I mean, we've had great success to date on that, and we actually found out that we were more, obviously, conservative in our design.

We thought dissolution would take a lot longer just based on some theoretical, and we found out it was, we were able to dissolve it quick, not much quicker but in a quicker time fashion.

Molybd recovery and purification, we're using two different ion exchange resins. And we've tested those both from a cold and a hot perspective using DU NU LEU. Uranium recovery processes, you know, it's been widely done worldwide.

Obviously we all know about the purex process, and we're going to be getting into our process later this afternoon, and you'll see some of the similarities.

Target fabrication processes and

techniques are used in uranium processing and fuel fabrication in the US and worldwide. And so these are not a lot different.

And in summary, we believe that our processes are well understood, reliable, and predictable. And we're finding that out through our testing. And I think that's it for us on Chapter 1 unless you guys have any other questions.

CHAIRMAN CHU: If there's no question, I would like to turn it over to NRC staff.

MR. BALAZIK: Good morning. My name is Mike Balazik. I'm the project manager for Northwest Medical Isotopes, and the research and test reactor licensing branch. Down on the end is my Branch Chief, Al Adams, and next to me is Dave Tiktinsky who is a Senior Project Manager in the fuel manufacturing branch with NMIS.

We're pleased to have this opportunity today to brief you on the Northwest Medical Isotope construction permit application. Today staff will be presenting current draft Chapters of 1, 2, 4, and 5 for the safety evaluation report for the Northwest production facility.

Before I get started, I just want to state that the Staff's presentation contains only public information. If during today's discussion we enter the realm of proprietary information, I ask that either Northwest or the staff please identify as such and we'll hold that for the closed session this afternoon.

Moving on to Slide 3, I'm just going to give you a brief introduction to the facility. This is kind of a companion presentation to what Northwest went over. But I'm going to be less focused on the physical design attributes of the facility and more on some of the regulatory considerations that we applied to reviewing this facility.

Northwest Medical Isotopes has requested from the NRC a construction permit to construct a proposed radio isotope production facility in Colombia, Missouri. The proposed radio isotope production facility meets the definition of a production facility as defined in 10 CFR 50.2.

Since Northwest doesn't have a utilization facility on their site, they'll need to transport these targets to be irradiated. Northwest proposes to use two research reactor, Oregon State and the University of Missouri Columbia to irradiate these targets with the potential of a third research reactor to be named later.

And just at a high level of production

facilities mainly composed of hot cells and process equipment to chemically separate out the molybdenum-99 and uranium from the fission products.

Slide 4, the main processes that Northwest includes, target disassembly and dissolution, molybdenum recovery and purification, and uranium recovery and waste processing.

Consistent with the guidance of the interim staff guidance to NUREG 1537, Northwest has provided an integrated safety analysis summary and a preliminary list of items relied on for safety.

Northwest plans on converting these IROFs into tech specs for the operating license application. Northwest has also provided a hazard and accident analysis using the consequence and likelihood criteria contained in the performance requirements in 10 CFR 7061. As stated in the interim staff guidance, the staff accepts this methodology for production facilities.

Now I just want to touch on the licensing approach. Since Northwest is proposing to process irradiated special nuclear material in its hot cells of greater than 100 gram batches of uranium 235, these hot cells are considered a productive facility as I mentioned earlier, as defined in 10 CFR 50.2.

Currently there are no production facilities operating in the United States. We have some regulatory experience with them. Recently we issued a construction permit to Shine Medical Technologies to construct both a utilization and production facility.

Also, West Valley performed fuel reprocessing quite some time ago under Part 50. And Cintichem up in New York State also produced molybdenum-99 starting in the late '60s. However, the uranium batches were below the production facility threshold of 100 grams that I mentioned earlier.

Northwest is proposing to perform target manufacturing at its facility. This activity includes the processing of new, scrap, and recycled uranium into a target form and loading that form into a target assembly.

Since the activity of target fabrication does not meet the definition of either utilization facility or production facility, that's not within the scope of the construction permit review.

Instead, target fabrication which is similar to the processes in fuel manufacturing will require a Part 70 license to receive Title and own, acquire, deliver, possess, use, and transfer special nuclear material.

Northwest will also be performing scrap recovery of special nuclear material. Scrap recovery means that as Northwest develops these targets, targets that don't meet specifications are reused to develop new targets.

10 CFR Part 70 subpart h requirements apply to scrap recovery. As with target fabrication, scrap recovery has processes and associated hazards similar to that of a fuel manufacturing facility.

MEMBER SUNSERI: Just a question right here.

MR. BALAZIK: Yes, sir.

MEMBER SUNSERI: It's more of a curiosity than anything else. From the commercial nuclear industry where you get a Part 50 license, and you're handling special nuclear material, you're transferring, you're doing all these things. And I think there's a license condition that covers, you know, the Part 70 piece of that. Why not the same case here? Sounds like they're going to get a Part 50 license and a Part 70 license. Why not one?

MR. ADAMS: You're absolutely correct that if you're a reactor facility, there's a Part 70 license that's sort of attached to Part 50 license. There's a Part 30 license for byproduct material, and in research reactors sometimes you see a Part 40 license for source material.

The difference here is the base facility that Part 50 in and of itself allows you to build, you know, very complicated buildings that without the other licenses are just that, very complicated buildings.

For this, for the target fabrication activity, it doesn't fall under the bounds of Part 50. There's no regulatory requirement to license the building separately. So then you're looking at the material and the use of the material.

MEMBER SUNSERI: Is that because the target is not incidental to what's going on at the Part 50 part of the plan?

MR. ADAMS: It's because the manufacturing of targets is not an activity that falls under the definition of utilization or production facility, and those are your Part 50 facilities. So it's not utilizing special nuclear material, reactors do that.

Or it's not the production activities which are either you're making plutonium, you know, the classic production facility, or you're separating special nuclear material from byproduct material.

By the time you're into target

manufacturing facility, that separation has already been done under the Part 50 facility.

CHAIRMAN CHU: But it's under the same roof though.

MR. ADAMS: It's under the same roof, yes. That's an interesting aspect of this.

MEMBER KIRCHNER: So to follow up on that, as the Applicant described, they do their safety related classification essentially using Part 70 rules. So could you explain this jumping back and forth?

I mean, in a simplistic world, at least starting with their schematics, you've got the target fabrication being under Part 70 and the actual reprocessing, the activities of interest for making moly under 50. Yet you're jumping back and forth to 70 for what appears to be a critical definitions of safety related activities, et cetera, and design bases.

MR. TIKTINSKY: Yes, this is Dave Titinsky, maybe I can answer that a little bit. It is confusing when you have both these facilities on there. So in 1537, the ISG we state in there, the staff states that an acceptable way of demonstrating compliance with Part 50 is using an ISA methodology.

MEMBER KIRCHNER: Right.

MR. TIKTINSKY: So they have decided, they have chosen to use an ISA methodology for the production facility. The application, even though we're not reviewing the Part 70 part of that, and the PSAR contains information as it relates to target fabrication.

So they were doing basically the Part 70, they will be doing a Part 70 methodology for that facility also. It just happens to be altogether in this particular submittal, obviously not complete because we don't have the Part 70 application.

So they're going to use the same methodology for both. So in this case if you think of the events that occur that they talk about and the IROFs, so the IROFs that would only apply to target fabrication are not subject to this Part 50 construction permit.

Only the ones that are related to this particular, you know, the dissolution of stuff that meets the Part 50 definitions is the subject of this particular review. But the ISA summary and the ISA that they've done covers the entire facility.

So there are a few complications of what we looked at, and there was a question before about, you know, friction integration of between 50 and 70. There are actually some differences because for the Part 50 part, you can use an ISA methodology, you can develop IROFs, but Part 50 requires you to have tech specs. They don't have, the word IROF doesn't exist in Part 50.

Well, in 70 it's the other way around. Tech specs don't exist in Part 70, IROFs do. So for this Part 70 portion, once that's submitted and approved, they will have to have Part 70 items, they will have to have IROFs there that don't get converted into tech specs.

They'll have to follow all the processes and you change process of 7072 and reporting requirements for the Part 70 piece. So there are some distinct differences between the two parts. But the overall methodology they're using is the same for both.

And I guess if you think about in the sum after we've received, you know, an operating license application and a Part 70 application, if you looked at this at that time, the ISA should cover everything and would have been reviewed in a complete manner.

MR. ADAMS: Let me add, you know, you mentioned geez, there's two different activities under one roof. That's not unusual. I ran a university research reactor which was licensed by the NRC, you know, Part 50 license.

I also had an SNM license issued by the

NRC, so I had to deal with the Part 70 world. Plus I had a state license which was covering byproduct material. All three licenses were under the same roof in the same building and I had to follow all the regulations and make sure that I kept things in the right bin.

So it's not unusual to have a place of use being a place of use under multiple licenses.

MEMBER KIRCHNER: No, I didn't have an issue with that, and I understand their approach and methodology. I'm curious about how you define safety related for this application.

MR. TIKTINSKY: So Northwest has put together a definition of safety related which sort of covers everything. That's why they have the sub-definitions of IROFs and non-IROFs because in the Part 70 methodology, you can have all kinds of things that are safety related.

But what you apply as an IROF, so you have a particular even that you're trying to make highly unlikely and you apply IROFs to make it highly unlikely. It doesn't mean you don't have other things that could be used as defense in depth that aren't necessary IROFs, but they're still safety related.

MEMBER KIRCHNER: So what are the

implications of using the terminology safety related as you review this application, in a general sense? We know that Appendix B is specific to power reactors. But what quality requirements are implied by using the definition safety related?

MR. ADAMS: Well, we will discuss that, the relationship between their quality assurance program, they don't have, you know, they don't have to meet Appendix B, the production facility does not. But there is a quality assurance program which relates to their safety related SSEs.

And again, that's a definition of Part 50, but that's a power reactor definition. So what the Applicant has to do is develop what they consider safety related SSEs, tell us about that, and that's one of the things that we review, do we agree with what their definition of safety related SSEs, and then how that falls into the quality assurance program for both safety related levels and seismic performance levels.

MEMBER KIRCHNER: Well, does the NRC have an explicit definition of safety related for this kind of facility?

MR. ADAMS: Does the NRC?

MEMBER KIRCHNER: Yes.

MR. ADAMS: I don't believe so.

PARTICIPANT: No, I don't believe so.

MEMBER KIRCHNER: So then this is a negotiated outcome between the Applicant and the spec?

MR. TIKTINSKY: So it's the Part 50 definition. So they don't talk about IROFs. So IROF wouldn't be considered in the definition of Part 50. So they blended a definition to try and basically cover what's in Part 50 but utilizing the Part 70 methodology. That's why you get the safety related IROFs and not IROFs designations.

MR. ADAMS: As an example, if you look at the review that was done for SHINE, a definition of safety related SSEs was developed that covered both nuclear safety and chemical safety that was reviewed by the staff and found acceptable.

MR. TIKTINSKY: So in general, would something like confinement be safety related?

MR. ADAMS: That's something that the Applicant has to tell us and we'll review that and either agree or disagree. It depends on what functions the confinement is performing.

And if the confinement is needed as an ESF to keep doses within acceptable limits. So the answer is it depends on what exactly the structure is doing. In most research reactors confinements are not safety related, but they're there more for ALARA purposes.

MEMBER KIRCHNER: But this is a reprocessing facility, so that's much different than a research reactor.

MR. ADAMS: Well, it's a production facility, which is different than a reprocessing facility.

MR. TIKTINSKY: So Northwest has identified --

MEMBER KIRCHNER: Misuse of terms, sorry.

MR. TIKTINSKY: Northwest has identified IROFs for different parts of their system, which we'll talk about obviously in more detail in distant chapters. So they've, I guess the word just confinement system's pretty broad.

So they've broken it down using the ISA methodology to determine exactly which things are IROFs and what are not IROFs and what's important to safety. So that's part of the next level of breakdown.

MEMBER KIRCHNER: Thank you.

MEMBER SUNSERI: So just one more clarification here. You mentioned tech specs and then you started talking about the IROFs. I would have thought that a production Part 50 facility would have tech specs that covered everything. But it sounds like there will be some additional safety requirements that are going to be driven by the IROFs which are not included in tech specs per what I heard you say?

MR. TIKTINSKY: So I guess the difference they're trying to say, so there's a different parts of the facility. So the target fabrication facility which is not part of the production facility will have its own world of IROFs that relate to those particular events for that.

So you wouldn't convert the Part 70 target fabrication portions into IROFs, I mean into tech specs because tech specs are not a Part 70 term. So for all the IROFs that are in the Part 50 production facility, as they've used their methodology, they have to convert those to tech specs.

MEMBER SUNSERI: So let me ask my question plainly then. Will there be a set of tech specs for one thing and another operating manual for other license conditions for that Part 70 piece?

MR. TIKTINSKY: So there will be a series of tech specs for the Part 50 facility. However, they want to define operating limits for their IROFs, for the target verification be part of what they submit in their application. So we haven't seen that yet, how they're going to define it. But IROFs --

(Simultaneous speaking.)

MR. BALAZIK: -- the answer is yes, you'll have two separate tech specs for the Part 50 and IROFs for the Part 70 for the target fabrication activity.

MEMBER SUNSERI: All right, all right. Well, thank you.

MR. ADAMS: The Part 70 facility is not required to have tech specs, by regulation.

MR. BALAZIK: That's correct.

MR. ADAMS: So that's an effect of having, of being in two different places in the regulations?

MR. BALAZIK: Yes.

MR. ADAMS: So the production facility will have tech specs. Those tech specs will meet 50.36 to control all activities that are significant to safety, important to safety, whereas on the Part 70 side it's the IROFs that basically serve the same purpose but have a different name to them.

MR. TIKTINSKY: And those are measures to make sure they're available and reliable.

MEMBER SUNSERI: Okay, thank you.

MR. BALAZIK: I just want to highlight some of the more important regulations concerning the construction permit. 10 CFR 50.22 puts you in the realm of a commercial facility under Section 103 of the Atomic

Energy Act, 50.30 requires an environmental report and to submit a preliminary safety analysis report.

Under 50.34 there's some other important regulations, meeting both occupation and public dose requirements under Part 20. Also after we finish our review of the application, the conclusion the NRC must come to is to whether the proposed facility can be operated and constructed at the proposed location without undue risk of health and safety of the public.

What we're looking at at 50.35 is what findings the Commission needs to make in order to issue a construction permit.

For this review there's another important regulation which we kind of talked about a little while ago, 7061. Even though this is not a requirement, as stated in the ISG, the staff has determined that the use of ISA methodologies as described in Part 70 and NUREG 1020, application of radiological and chemical consequence and likelihood criteria are contained in the performance requirements, designation of items relied on for safety, or otherwise IROFS, and establishment of management measures are acceptable ways of demonstrating adequate safety for a medical isotope production facility.

Just a quick note. There are a number of regulations that don't apply to the Northwest facility. One of the most significant ones is Appendix A to Part 50, the general design criteria. However, Northwest is still required by 50.34 to have a principal design criteria.

Another regulation that doesn't apply is the siting requirements of Part 100 that were specific to a nuclear power plant and test reactors. However, in NUREG 1537 there's criteria for siting that we reviewed.

Also Appendix B that Al mentioned earlier doesn't apply to this type of facility. The ANSI standard 15.8 which is the quality assurance program which somewhat mirrors Appendix B, and if not it goes into more detail on some of the attributes.

For example, experiments, you won't see anything on experiments on Appendix B, but it goes into more detail on experiments on the ANSI standard.

MEMBER SKILLMAN: I would like to go back to Matt's question on IROFS. I'm looking at the slide from the NWMI presentation there, 13. And on that slide they write translation of IROFS Part 70 to tech specs Part 50 will be developed.

What gave me comfort at the end of the discussion with NWMI is that there would be, at least

I imagine that there would be a set of tech specs that govern 50 and 70 processes, both sides of the house.

What I think I just heard you say, Dave, is there will be IROFS, excuse me, there will be tech specs for the Part 50 side, but not for the Part 70 side. And as I read further in this application, there are going to be two super whamodyne computer systems that govern this whole facility.

One's on the process and one's for the overall architecture of the plant. So I'm thinking there's a control room somewhere with a couple people like us that are operating this place. And if that group of individuals has a book, it's either a physical book or an electronic device that has technical specifications.

And when the bell goes ding, they know exactly what to do, whether it's on the Part 50 side or on the Part 70 side. So please clarify whether or not there are tech specs for the Part 50 side.

MR. ADAMS: The answer to that question is yes, there's tech specs for the Part 50 side because 5036 requires them.

MEMBER SKILLMAN: Are there tech specs for the Part 70 side?

MR. ADAMS: There is not a regulation that requires tech specs for Part --

MEMBER SKILLMAN: That's not the question. I don't care whether it's regulation or not. Is there something that says hey, go do something, you got a problem down here. And it's written in a way that is an enforceable action on the people that are running this place?

MR. TIKTINSKY: So an IROF will have some kind of designation that something can happen or not happen. And the IROF safety systems will either shut something down or prevent or mitigate something.

So normally in fuel facilities, things that they would have in the control room, they would have indicators below that limit to try and indicate that something was going wrong before it IROF or challenged because the Part 70 methodology is that you don't want to have to challenge IROFS even though they're there if you need them.

So the Applicant would develop some type of operating limits that they would track in their control room. We don't know the details of what they would be yet because we don't have an application. But they will have something.

It will not look like, it won't be called a tech spec because that's not a requirement. But it could be, like, an operating limits manual or something. Again, I'm not sure how they'll handle it, but they'll have to have something that they will track, and there will be alarms that will go off based on whatever the functions are.

So in the case of, you know, there could be an IROF detector, the IROF detector goes off based on some limit, and that would be indicated in the control room that that was challenged.

MR. ADAMS: So there will still be procedures for running the facility --

MEMBER SKILLMAN: Yes. Perhaps we'll discuss this this afternoon, but I'm going to go after this sentence on Chapter, on Slide 13 of the Chapter 1 presentation from NWMI. And that statement is translation of IROFS Part 70 to technical specifications Part 50 will be developed.

And so I would probe your safety evaluation and their commentary here because that to me is the hook that would give me confidence that there's going to be the integration that I was asking about earlier between the Part 50 side of the house and the Part 70 side of the house.

I see that integration occurring at the tech spec level.

MR. ADAMS: And if I can ask Northwest, I mean, we're giving you our understanding. Are we misrepresenting?

MR. REESE: This is Steve Reese. Is it on? So what they're saying is correct. That sentence in the presentation this morning is driven by the fact that we've chosen to use the Part 70 methodology. I say methodology on the Part 50 side.

And so as you go through that, that Part 70 methodology ISA forces you to write things in terms of IROFS. What we fully intend to do for Part 50 because we're absolutely required to is take those IROFS and translate them into tech specs.

And in Chapter 12, we specifically address that actually, how we're thinking about taking the IROFS and basically it's just, essentially it's rewriting it in a different format because it's going to be for the same thing.

An IROF and a tech spec should have the same weight in terms of safety and administrative function, or I should say operational function. So we don't really, we realize that we're in sort of a, we're caught between two worlds a little bit.

And they asked us to comment on that in Chapter 12, about how we intend to take the IROFS and covert them to tech specs so we can meet Part 50 spec requirements. But in our view, an IROF and a tech spec have the same sort of weight, as it were. But that was the intent of that line in our presentation this morning.

MEMBER BLEY: Steve, I take it then that you won't really have the tech specs until you come in for an operating license?

MR. REESE: That's correct.

MEMBER BLEY: Okay, it's just how you're going to do it is explained now.

MR. REESE: Yes. In Part 12 we talk about what it's going to look like.

MEMBER BLEY: Okay, haven't read that yet. Thanks.

MR. ADAMS: Thank you.

MR. BALAZIK: So now we're looking at the regulatory basis for issuing a construction permit under 5035. And in other words, when we're going to decide we can issue a construction permit, we have to come to these conclusions, that we have a good understanding of the principal architectural and engineering criteria for the design, that any missing technical or design information can be reasonably left for later consideration and will be updated in the final safety analysis report, that research needs have been identified and will be addressed.

And what we're determining right now is do we have enough information to authorize Northwest to commence and then complete physical construction activities, and do we have reasonable assurance that the methodologies that they're applying to this preliminary design of the facility will lead to the facility being built and operated without undue risk to the health and safety of the public.

MR. ADAMS: Can I step in for a second? So I think these next couple of slides are probably the most important slides of our presentation on Chapter 1. And it's methodology, and it's that finding the right spot.

I mean, at one end of the spectrum you know nothing about the design or safety, at the other end of the spectrum you've issued an operating license. And somewhere in between is the construction permit that we have to make a judgement that we can meet these findings which are pretty high level and allow for a lot of flexibility in moving forward.

And the applicant has a choice, too. The last construction permit that the NRC issued for a research reactor, that licensee at the construction permit stage also handed us the operating license application. So it was a complete, finished SAR. There was no PSAR or FSAR, it was just the SAR.

So you know, there's a different level of how far you can mature your design, you know, once you reach that minimum for a construction permit. And there is, you know, the licensee is taking on some risk of moving ahead and doing construction activities without an operating license because until we see that application and review it and approve it, there's no guarantee.

So I think that's an important aspect of this. And that's sort of the power of the Part 50 process, and also probably what led to, you know, the Part 52 process too.

MEMBER REMPE: So when we get the review for SHINE, we struggled with this a lot on where that line is. And so just to, when I read, I believe I saw the staff has made decisions in many if not all places not to do independent calculations on the material that was submitted by MWMI because they just said well, we're going to wait until the FSAR.

I believe that's what I read a lot of places if not all places. The other thing though is did you go into their quality program? They've done a lot of calculations. Did they have an independent reviewer?

Did you do that kind of -- I'm trying to understand what you, because it is a flexible line I learned from the SHINE evaluation. And so where did you draw the boundary on what you reviewed from them?

MR. ADAMS: Well, I mean, we review the application that was given to us.

MEMBER REMPE: But you didn't do independent calculations?

MR. ADAMS: I believe you'll see some work we've done calculational wise in the criticality area.

MEMBER REMPE: Okay.

MR. ADAMS: So there are some calculations we've done. But it boils down to, you know, is there enough information and is that information of a maturity that we performing independent confirmatory calculations will confirm anything.

And that's always a judgement call if we're in the right place. And --

MEMBER REMPE: You don't want to waste money. I understand why but did you at least see if they did, I mean, doesn't Part 50 require you have an independent review of the work they did?

Did they submit that, and did you get into enough detail you can say X, Y, and Z parameters are really important, you need to have some data because we don't necessarily believe that? I mean, I'm kind of trying to understand at a high level what you think the review did or didn't accomplish.

MR. ADAMS: I think as you see, as we go through individual chapters you'll see what we've looked at, what we didn't look at, you know, what we said can be put forward. And you know, just like with SHINE, the future can manifest itself in two ways. One is on the construction permit there could be constraints on the construction permit.

Or in our SER there could be a listing of future what we consider commitments, open items, I'm not sure what the right word is. But you know, issues that we need to keep track of and make sure that they are adequately handled in the operating license application.

MEMBER REMPE: And I haven't, again maybe it's just where I've read and I've not read all the chapters yet, but I haven't see that list of X, Y, and Z parameter, you need some data, we don't necessarily believe that in what I've reviewed so far. And if I just hit the wrong chapters and there will be or there are some --

MR. ADAMS: I think it depends on the

system, but some systems we've gone into deeper than others. But the depth we can go into is the application. And in cases, you know, we've asked a lot of RAIs, and the answer to some of those RAIs is, you know, the applicant has said this is something that we'll take care at the operating license.

MR. BALAZIK: And those will be the items that we flag for follow up on.

MEMBER REMPE: So this thing about Chapter 2 and the fact there's some data, the SE said hey, they're supposed to have data by the first quarter of '17. And I believe we'll see later today you said they can wait until the operating license.

MR. BALAZIK: That was a question that we had asked Northwest during the RAI process. And that was a response. We realize that Northwest is constructing at risk, and this is information that we will review. It will be an item that's captured for review. But realize they're constructing at risk with that information on how we review it.

MEMBER REMPE: Their response didn't convey that. But that's the way it should be taken because it's not flagged in the SE that they're at risk, but the presentation --

(Simultaneous speaking.)

MR. BALAZIK: I mean, the entire process, you know, unless they hand us an operating license that we reviewed and approved, there's always risk. And like I say, that's sort of the one attribute of Part 50 that you can go ahead and move forward.

You know, but as you can see, these conditions that, research and development can still be ongoing as long as it's wrapped up by the time we issue the operating license. So there's a lot of flexibility for loose ends.

MEMBER KIRCHNER: Let me ask a question here on your third bullet. And let me preface it by observing that we have a facility that's being attempted to be built that cost billions of dollars with hundreds of years of experience in a state in the Northwest that is way over budget, and they did not do pilot line RND before the construction started.

Things went south in the seismic area. But crucial to that facility was understanding the process chemistry. So we heard from the applicant that there is some RND underway.

Are you confident that, at least from a safety perspective because they will do this at economic risk if it doesn't work properly, even if it's safe, that the major issues that you expect to focus on, particularly, I used the wrong word recycling in the production activities can be conducted safely?

And issuing a construction permit without high confidence in that is more of a risk for the applicant than it is for the staff and the NRC. But what is your sense right now with regard to RND requirements and where they are?

MR. TIKTINSKY: If I can try to answer a little bit. And a lot of it, it's just the nature of how we're presenting chapters to you because the details that we're talking about, the criticality review, the chemical safety review are, you know, Chapter 6 and Chapter 13.

So our reviewers have gone in and asked some of these questions and in the case of the chemical process have looked at --

(Off microphone comments.)

MR. TIKTINSKY: Yes. So the chemical process, I mean, our chemical reviewer has looked at it in great detail and asked questions and has questions. And when you see our safety evaluation report, you'll see some of the, you know, the summation of that.

So it's sort of just the nature of Part 50 that you have this preliminary design. It's a little different, I usually work on Part 70 where it's more defined in terms of what's required at the stage of your license. That's not how Part 50 is.

So there's a lot of preliminary things that you, you know, you hope that what they're saying is okay. You ask a bunch of questions on it, and obviously the applicant has to demonstrate by the FSAR what, you know, the real truth is, how they're going to, exactly what the requirements are and where they're limited on identifying the events and the processes.

So we brought them up in the staff review and questions, and again, you'll see it as you read our SER chapters. So I'm confident that our technical reviewers are asking the right questions.

How the answers will come out will be somewhat dependent upon their research activities and sort of addressing, you know, the details once they get into a final design.

CHAIRMAN CHU: Related question. I notice there's tons of internal technical documents from NWMI. Did you have to dig into a lot of them, or you depend on your RAI process for them to give you the information?

MR. TIKTINSKY: So as we always do for a technical review, you know, each sort of discipline kind of chooses how far they want to dig down into doing what we call vertical and horizontal slices.

So in the case of criticality there is, you know, a series of criticality safety evaluations. But our reviewer chose to pick what they thought was the highest risk one and look at that, and really to make sure that the methodologies are correct for what they're doing and ask questions on that.

The detail review of the operating license, you'll have another vertical slice and in more detail once those things are established, but the staff always does a sampling approach. So we'll look at, you know, a few of the different areas that we think are at a highest risk significance, drill down on those, verify, look at the calculations, deal with the applicant.

You know, an in conversation, make sure we understand and make sure that they're on track. But again, we sort of use the sampling approach on that.

MR. BALAZIK: Dr. Chu, just to further elaborate on that, when we did the technical review, I asked the technical reviewers, look at the PSAR. They have lots of calculations in there. What calculation are you interested in looking at.

And that's when we used the Dropbox method. When a technical reviewer requested the calculation, we would put it on Dropbox where the reviewer could look at the details.

Now for the example of criticality, our criticality reviewer had some specific questions on those documents, and then Northwest actually submitted those to the NRC on the docket for those questions.

MR. ADAMS: I guess that to circle around back to the original question on the research and development, I believe those activities are gathered and summarized in our SER.

PARTICIPANT: They are identified.

MR. ADAMS: So the research and development activities at the construction permit is based on our gathered and summarized. So we know what those open items are that will be closed at some point in the future.

And I'm glad that we're having a good conversation, and I wanted to stop because of this issue, you know, where do you stop the review for your construction permit and how much risk is there to the applicant.

And that's up to the applicant as to, you know, if they get their construction permit, if they want to start building the next day or do they want to submit an operating license next. But that's up to the applicant. But the applicant understands what their risks are in this process of licensing.

MEMBER BLEY: It's not just their risk, I don't think, Al because as I read the requirements on the staff for doing this review, I mean, it kind of separates what you do at the CP stage from later is on these uncompleted areas, be they RND or maybe something else, I believe you're supposed to have reached the conclusion that it looks reasonable that they'll be successful as they go forward.

And I kind of expected to see that in the findings as I went through. And I don't think I do see that summarized in the findings, but I might have --

MR. ADAMS: Well, we have a few more slides. But this is what the regulations say. So if we can make these findings and meet the other regulatory requirements, we can issue a construction permit.

And I'm not saying we're not, you know, we don't have any role here. Indeed, we do have an important role and we have a responsibility that there is reasonable assurance that as this project moves forward it will be successful.

I mean, we're not going to, you know, something we see going in the wrong direction we're not going to sit there, shrug our shoulders, and say oh well, it's a construction permit.

MEMBER REMPE: So I would like to just emphasize again because we've seen some problems with other applicants or licensees about when you go through and you look at their stuff, did you a detailed, and do you have confidence -- a detailed review and do you have confidence that the quality of what you're seeing has gone through the, what you require with respect to independent peer review that -- did you go through and do some checks on that because that is something that you can determine at a high level.

They've got the right processes in place. And I don't see that was written, and I'm kind of asking your take on it.

MR. ADAMS: Right. Well, that's because we haven't gotten to the quality assurance part yet. But I think as you saw with the other review that quality assurance is very important to moving forward. The quality assurance of the application and the quality assurance of the construction activity.

So the answer is that probably that's one area where we do look very carefully is making sure the quality assurance program is mature and it's doing what it's supposed to do.

MEMBER REMPE: And so far you're having a good feeling about it?

MR. ADAMS: Right. We're not at the point where, you know, inspectors are not going out in the field and digging through, you know, paperwork at their offices or anything like that.

MEMBER REMPE: Okay.

MR. ADAMS: It's basically it's just a review of the information in the application at this point.

MEMBER REMPE: So even for the whole construction permit, you won't be doing any sort of inspections?

MR. ADAMS: Once the construction permit is issued, yes there's a --

MEMBER REMPE: Before the construction permit is, you just don't do that?

MR. ADAMS: There's no field inspections before the construction permit is issued.

MEMBER REMPE: Okay.

MR. TIKTINSKY: Can I just add that we review at this point the quality assurance program that's presented to see if it meets the requirements, in this case the ANSI standard. And after that is done, the staff with the region, the region does the inspections for quality assurance.

We'll do both specific inspections related to construction as well as programmatic inspections for things like design control and corrective action and other parts of the quality assurance program to verify the things that you're talking about that, you know, you say something somewhere, have you followed through and made sure you have a change in your design in all the other aspects.

So those inspections will be done. But at this point, we're just reviewing it, whether the program is sufficient.

MEMBER REMPE: Okay. I just think with some of the calculations you would review, that you would get a feel for the quality of what's being done if the processes were in place. Again, the independent peer review, I keep harping on that and how it's done and implemented is something that seems like it could be checked now.

MR. ADAMS: I think what you say is true by, you know, let's say the one area I'm most familiar with is reading about the work that was done in criticality. And you know, the reviewers are very knowledgeable in what they're doing and they can I think quickly determine if a set of calculations have quality behind them and are done in a proper way. And ask RAIs to get the information they need.

MEMBER REMPE: Okay, thank you.

CHAIRMAN CHU: We need to roll a little bit. We're 45 minutes behind already. Okay, thanks.

MR. BALAZIK: I'm sorry, I'll try and speed it up a little bit. There are a couple of other standards that need to be met for issuing of a construction permit as outlined in 5040 and 5050, reasonable assurance that construction of a facility will not danger public health and safety, financial and environmental requirements are met.

I just want to add that the final environmental impact statement for the proposed Northwest facility was issued in May of this year.

Issuance of a CP would not be inimical to a common defense and security of the public, and meets the standards and requirements of the Atomic Energy Act and our regulations, and that outreach studies be conducted.

We've kind of already talked about that, about this slide, construction versus operating. Al kind of talked about the differences, basically at the construction stage we're primarily concerned with whether licensee can safety commence a complete physical construction activities.

A construction permit does not approve the safety of any design feature or specification unless specifically requested by the applicant. In contrast, when we issue an operating license, this is when we say that based on final design of the facility, there's reasonable assurance that the facility can be operated without endangering the health and safety of the public.

So even though Northwest can build the facility with the issuance of a construction permit, it's not allowed to operate until the NRC issues Northwest an operating license.

MEMBER KIRCHNER: Has there been any specific request for approval of any safety feature of the design?

MR. BALAZIK: No, sir. Just some of the regulatory guidance that we applied to a review of this facility. Primarily used 1537 as augmented by the interim staff guidance, the ISG was specifically developed for the review of a production facility and aqueous homogeneous reactors.

This was largely based on the guidance in NUREG 1520 because the most appropriate technical yardstick for this type of facility is 1520. Other guidance that we used, there were numerous ANSI standards that we applied that are referenced in the documents that our reviewers used, for example, 15.8 for quality assurance and ANSI standard 1516 for emergency planning.

MEMBER SKILLMAN: Michael, let me ask this.

MR. BALAZIK: Yes, sir.

MEMBER SKILLMAN: Specifically related to using NUREG 1537, in Chapter 1 of the PSAR you used 1537 instead of 10 CFR Part 100. What do we need to understand about why you chose one versus the other?

PARTICIPANT: Well it's the highest level answer to that question, it's the regulations. Part 100 applies to nuclear power plants and testing facilities, better known as test reactors. So because this is not one of those facilities, Part 100 does not apply.

At that point we use NUREG 1537, and the attributes of what gets looked at as far as attributes of the site and also accident dose requirements. Part 100 gives you the dose requirements for that bounding accident. Am I answering your question?

MEMBER SKILLMAN: You did. Thank you.

MR. BALAZIK: All right, so here are the review areas spelled out in NUREG 1537. Realize that the ISG provides additional guidance on production facilities, but we will be presenting all these chapters to the ACRS subcommittee this summer.

And just at a high level, the summary of Chapter 1 review, there aren't any acceptance criteria for Chapter 1 but there are some general things that we look at for introduction to the facility.

Did Northwest ask for a licensing action that was in line with the Atomic Energy Act and the regulations that we have in 10 CFR? I think for the most part we're pretty satisfied that they've done that.

We look at when you're constructing your facility, does it share equipment with any other facilities? Since this is a new construction, the proposed facility will not share any systems with another facility.

We also look at comparison to other technologies. What Northwest is proposing to do is not new technology. The molybdenum purification uranium extraction systems are similar to other facilities around the world. And as I said earlier, Cintichem which was licensed by the Atomic Energy Commission used a similar purification process back in the late '60s.

Also, there won't be any high level nuclear waste at the site or spent nuclear fuel so the Nuclear Waste Policy Act is not applicable.

MEMBER KIRCHNER: Since you reference that aging, that long ago facility, are any of your staff knowledgeable about that?

MR. ADAMS: I did find, well are we talking about Cintichem?

MEMBER KIRCHNER: Yes.

MR. ADAMS: So Cintichem, it initially went into operation in the '60s. However, Cintichem was operational until the early 1990s, and I was the licensing project manager for Cintichem while it was operating, and I also took it through decommissioning.

MEMBER KIRCHNER: No, I just wanted to establish whether there was any link or you were just throwing that out as an interesting factoid.

MR. ADAMS: Yes, and some other links. He's retired now but for a number of years on our staff, both in the licensing and in the inspection part of the research reactor groups was the last operations manager at Cintichem, Dr. Marc Voth.

And also when we were writing the ISG for the production facilities, for the medical facilities, we had under contract the last facility director at Cintichem. So we did try to harvest that knowledge.

MEMBER KIRCHNER: Thank you.

MEMBER SUNSERI: So I just, I can't help it but I want to poke on this Part 50 license versus Part 70 one more time here. The second bullet says WMI facility does not share systems or equipment with other facilities, yet they're essentially two facilities under one roof the way you're treating it from a license perspective, from what I hear.

MR. ADAMS: Right, and that's, and I know that finding was going to get a question. It's a finding related to NUREG 1537. And it's looking at, you know, is that reactor facility that's a room in a chemistry building, is it getting its electricity from the rest of the engineering building. Is it getting its water from the building.

It's not that interface that you're talking about and indeed that the interface between the Part 50 and the Part 70 facilities. There is another phase, and that's another phase that needs to be looked at.

MR. BALAZIK: And I think this is the last slide. Just an update on the safety evaluation report that we're near completion of our complete review of the PSAR. Northwest has submitted revised Chapters 1, 2, 4, and 5 incorporating REI responses.

And the goal of the staff is to present

chapters that have a technical link, just to give the ACRS members a complete picture. And note the staff plans to complete the safety evaluation report by October 2017.

That completes the staff's presentation. Any additional questions?

CHAIRMAN CHU: If there's no urgent questions, I would like to take a short break for 12 minutes. So everybody come back at 10:50.

MR. RICCARDELLA: Margaret, this is Pete Riccardella. Hello?

CHAIRMAN CHU: Yes.

MR. RICCARDELLA: Yes, so I've been on the line for the last half hour, so I'll stay on.

CHAIRMAN CHU: Okay, thank you.

(Whereupon, the above-entitled matter went off the record at 10:37 a.m. and resumed at 10:50 a.m.)

CHAIRMAN CHU: We're resuming the subcommittee meeting and now we'll have Chapter 2 from NWMI.

MS. HAASS: Are we ready? Oh, sorry, my ears are clogged. I can't hear. So I'm Carolyn Haass. We're going to start the presentation on Chapter 2.

I know that there's a lot of fun stuff in

Chapter 2 for nearby facilities and all of that, but then there's also some basic data, whether it be, you know, population, meteorological, geology, hydrology, seismology that is used in the rest of the chapters, and so I was just going to briefly go over some of the, you know, the basic data, then Gary's going to go over some accident scenarios, and then we'll get into the geology, hydrology, and seismology.

So on population - oh, I forgot about that slide. So I think as we've already discussed earlier, our site location is in Columbia, Missouri at the Discovery Ridge Research Park. It's about five miles from the MURR facility, so it's kind of a unique location.

We are 125 miles from Kansas City and 125 miles from St. Louis, so I guess that's convenient for us. You can go to either place. We're four and a half miles south of I-70, and you take Highway 63 from I-70 to get to the site, and the site is right off Highway 63.

We're about three and a half miles from the main MU campus, the University of Missouri campus, and 9.5 miles west of the Missouri River. And as Gordon said earlier, we're about, what, 23 miles from Callaway which I don't have on this.

So population distribution within five miles, when this was developed, the City of Columbia does their own land use planning, and the study that they put together in 2013 states that they're going to have an annual growth rate of about 1.5 percent in the city.

The Missouri Department of Administration though does the state and county population growths, and that varies based on the year, but their planning is like from 2011 to 2015. They're looking at 1.58 percent growth, and then as you go into the future, it actually drops to one percent around 2031 to 2050.

So the state does - the city and state do use different land use planning models, and I just wanted to bring that up, but what you're seeing in this resident population is there is a growth from 2010 to 2015, you know, of about 24,000 people within a five-mile distance of the research park where we're going to be.

MEMBER STETKAR: Carolyn?

MS. HAASS: Yes?

MEMBER STETKAR: I looked at the transient population statistics and estimates that you had in the report, and I'm kind of curious about a couple of things.

MS. HAASS: Okay.

MEMBER STETKAR: If you go back to your cover slide -

MS. HAASS: The cover slide?

MEMBER STETKAR: Yeah, the facility over there on the lefthand edge of the picture is identified, and the number of employees in that facility are identified. How come the facility right across the street is not identified?

MS. HAASS: It is. It's the RADIL facility.

MEMBER STETKAR: I'm sorry. It's identified on this slide. It's not identified in your PSAR. Trust me, it's not. I would just put that on the record.

MS. HAASS: Okay.

MEMBER STETKAR: Now, second question, more importantly because you're talking about population growth, when you look at - there's a table 2 dash whatever the heck it is. It doesn't make any difference, 2-3. I'm sorry. The growth is 2-8.

MS. HAASS: Two dash -

MEMBER STETKAR: And there are some figures, 215 through 221 that show the growth in the population within a one to two kilometer band around the facility. It's really interesting since this is going to be one of the most dynamic growth areas for the University of Missouri Technology Park that there's only very modest growth in only one sector, and that happens to be the sector where that building is on the lefthand edge of the slide. Why isn't there any other growth in the transient population in any other sector around the plant in the next 35 years?

MS. HAASS: I can't speak for the University, but -

MEMBER STETKAR: All right, it's - no, I'm sorry. If this is a dynamic Discovery Ridge Technology Center, why isn't there a single, not even one person in any other sector other than the one going toward that one building in the next 35 years? It doesn't strike me as a reasonable projection of the growth, just it's on the record. You're not going to be able to answer it today.

MS. HAASS: I understand, but I will say that we did go out to obviously the city, and the county, and the state. We did look at projects that were being looked at for the future, and the university did not give us any growth data, and I will - I can go back to them.

MEMBER STETKAR: Apparently the farm fields will surround you for the next 35 years then.

MS. HAASS: Okay, thank you.

MEMBER STETKAR: On Technology Ridge. I guess the roads aren't ever going to be completed either.

MS. HAASS: The one in front of the facility -

MEMBER STETKAR: Oh, it's there. Believe me.

MS. HAASS: Yes.

MEMBER STETKAR: I took a walk around on Google Earth. It's a wonderful thing.

MS. HAASS: Yeah, I mean, so I think, you know, the only two future projects that were listed in the report were on page 2-42, and they were the Global PET Imaging Facility and Old Discovery Park which we kind of laughed at, but, you know. I understand your comment. Thank you.

So obviously in Chapter 2, we look at all the nearby facilities, and we did an investigation of any industrial, military, transportation facilities within five to 10 miles of the facility, and then we looked at the - we summarized them up and you're seeing them here. You know, there are industrial facilities such as 3M or AT&T or the Municipal Power.

There's, you know, major waterways. There's the Missouri River. There are some pipelines and definitely fuel storage facilities. There's four airports, three heliports. And so what you're going to see in the next round of slides is our evaluation of those nearby facilities.

MEMBER STETKAR: Carolyn, I'm trying to look ahead in your presentation. Are you going to talk about pipelines specifically or should I ask about pipelines now?

MEMBER BLEY: Before you answer that, the paper you just flipped onto the microphone drives our recorder crazy over here, so be careful.

MS. HAASS: I'm sorry. We do talk about it some, but you'll probably have some questions.

MEMBER STETKAR: If you have another slide that's going to address it, I'll wait for that point. I didn't see one specifically. That's all.

MS. HAASS: Okay, slide 26, what it does is it's showing the significant industrial facilities within 10 miles, the major -

MEMBER STETKAR: Okay, I'll wait until then.

MS. HAASS: Yeah, the major pipelines and

-

MEMBER STETKAR: Okay, okay, good.

MS. HAASS: And it's talking about, you know, it shows the distance, the direction, and the type of materials like for the industrial facilities that they have, the pipelines, the type of product they have, and then the major storage facilities such as the pipeline company breakout tanks and Ferrellgas. And we're going to go through about eight or 10 slides and we're going to be talking about some of this information.

MEMBER STETKAR: Yeah.

MS. HAASS: Especially from, you know, an airport, heliport perspective, as well as some of the industrial facilities.

MEMBER STETKAR: Let me ask about the pipeline then since -

MS. HAASS: Okay.

MEMBER STETKAR: I looked on the national pipeline mapping system and I think I found a pipeline that you don't list in your PSAR, and that's a pipeline. It's a natural gas pipeline, 10-inch line, that's owned by Ameren, I guess. It's fairly recent. I can find newspaper articles that it was built in 2014. That's before now.

It extends up and down 63 from Columbia down to Ashland, and it takes - it actually takes kind of an interesting jog around the Discovery Ridge Technology Center. It's sort of an interesting routing.

As best as I can tell from Google Earth, it's closest distance to the facility is about 2,000 feet which is a heck of a lot closer than any of the gas lines you have listed on this slide here, so I was curious why you didn't list that pipeline.

MS. HAASS: Well, we do have one Ameren natural gas line.

MEMBER STETKAR: You do, three and a half miles away.

MS. HAASS: Yeah.

MEMBER STETKAR: Yeah.

MS. HAASS: You're correct.

MEMBER STETKAR: This is not that one.

MS. HAASS: And just to let you know, this was actually written in 2014, so if it was being constructed, it may have not been up on that database, but I don't know. I will have to go back and look.

MEMBER STETKAR: You may want to check it just -

MS. HAASS: I will.

MEMBER STETKAR: But I'm curious because it is the closest pipeline to the facility. I couldn't get exact - as I said, I took a walk around the neighborhood -

MS. HAASS: Right.

MEMBER STETKAR: - and on whatever you call it, the little walking guy -

MS. HAASS: Right.

MEMBER STETKAR: - you can see the little markers where the pipeline crosses a couple of roads, so I know it's there.

MS. HAASS: I will definitely go look at that, and when we meet next time, I'll get that updated.

MEMBER STETKAR: Thank you.

MS. HAASS: No problem. Slide 27 shows the estimated potential hazardous chemicals that would be within a radius of five miles of the site. Obviously this is through, you know, transportation oriented, you know, on a truck.

MEMBER STETKAR: One more thing on the pipeline, sorry. You'll find that I'm like Colombo sometimes here. You list the Magellan gasoline, liquid petroleum pipeline, and you list one as being inactive and one as being in use. I think you have them reversed in your PSAR. The PSAR says that the active one is to the north of the site and the inactive one is to the south of the site.

As best as I can tell, the inactive one is to the north of the site going through town, and the active one is to the south of the site, which is not surprising because it connects to the big tank farm down there, so you'd think that they're probably -

MS. HAASS: That actually makes sense.

MEMBER STETKAR: - pumping stuff through that pipe. It affects the distances obviously to what you call an active liquid petroleum pipeline.

MS. HAASS: I agree. I'm going to turn this over to Gary and we're going to talk about air traffic.

MR. DUNFORD: Which slide are you on?

MS. HAASS: 28.

MR. DUNFORD: Okay, so this is Gary Dunford. So in the next set of slides, we're going to really talk about the nearby facilities which include the air traffic, and there's three aspects of that we'll talk about which would be the airports themselves, the heliports, and then the airways, and then we'll move on and talk about explosion, potential impacts, screening stuff that was done and probability evaluations that were done for the impacts on the highway and the nearby industrial facilities.

We'll talk a little bit about fire and vapor explosions, plant vapor explosions, and then toxic gases, and then we'll finish. There's a little bit on the onsite diesel is another accident that's been evaluated.

So if you'll look at the air traffic to start with, there's three airports and there's the three helicopter ports. We'll just talk about the airports first. They effectively screen out using the NUREG guidance of the 2000 D squared. That's what this table shows on slide 28.

The only airport that has meaningful flight data is the Columbia Regional Airport, and that flight number is around 1,600 or 16,000 a year, and the D squared value is 21, so there's a little bit of margin in that.

The Cedar Creek and the Sugar Branch are smaller single runway type of deals and they - we had estimated one flight or two flights a day is kind of what we used out of those smaller airports, and obviously they screen out. They're a little bit further away and so they're all screened out per NUREG 1537.

MEMBER STETKAR: Gary?

MR. DUNFORD: Yes?

MEMBER STETKAR: Where did you get the operations data for the Columbia Regional Airport, 16,610 operations per year?

MR. DUNFORD: That's a reasonable question and I will fess up. I am not the author of this area.

MEMBER STETKAR: Well, let me -

MR. DUNFORD: But I am the representative for this area, so I'm supposed to be able to answer all of those questions, I suppose the 12-month period in October of 2013.

MEMBER STETKAR: Sure, so I - because you had 16,610 and you said it averages 26 flights per day, and that didn't divide out correctly, so I decided I'd go figure out how many flight operations per day there are, so I looked at the FAA air traffic activity system database.

Its acronym is ATADS, and I looked at four fiscal years ending in September 30, 2016, and the average number of flight operations at the Columbia Regional Airport annually over those four years is - let's see, where's my number - 21,292. It's a little more than what you have there. It's just slightly less than your 21,632.

I noted that if there had been one more average flight operation per day every year, you would have been over the limit, or if your facility was a tenth of a kilometer closer to the airport, you would have been over the limit, so I'm really curious about your very large margin of 16,610 to 21,632.

In fact, one of the four years, it was over the 21,632, but that's not fair because there's a lot of general aviation traffic out of there, so you get variability, not a lot of variability though, not a lot of variability. I can cite the numbers if you want. I've got the printouts from the FAA.

MR. DUNFORD: No, this is the - you're right. We'll need to look at that.

MEMBER STETKAR: Okay.

MR. DUNFORD: This is the data from 2013 as Carolyn pointed out earlier.

MEMBER STETKAR: Yeah.

MR. DUNFORD: The report, the Chapter 2 and Chapter 19 were actually submitted initially in 2014.

MEMBER STETKAR: One of the fiscal years. I made sure that I went back and I picked up fiscal year 2013. It's one of the four.

MR. DUNFORD: I assumed it would be.

MEMBER STETKAR: And in that year if you want it on the record, the first one I have in that year according to the FAA, there were 21,902. That's the year of the four that was actually over your magic number.

MR. DUNFORD: Okay.

MEMBER STETKAR: So I would go back and check those numbers. I'd be curious why the staff didn't do that. It's a five-minute exercise. There's another part of your PSAR when you talk about airports where you say there are no military facilities or military training routes in the vicinity of your facility which is correct. There are no military training routes.

On the other hand, if I look at the statistics, and FAA keeps this also, about seven percent of the operations at the Columbia Regional Airport, over those four years I looked at anyway, were cited as military operations. Do you have any idea what kind of military aircraft used the airport and what kind of operations they had?

When you pull up the airport statistics on AirNav which is another useful site, you notice that there's some number of military, a small number, and I've forgotten how many and don't want to look it up right now, military aircraft normally at the airport. So I don't know whether - I couldn't find anything on Missouri Air National Guard operations there, but there's some sort of military activity there.

MS. HAASS: So let us get back with you on that.

MEMBER STETKAR: Okay, those are the two I had on airports.

MS. HAASS: Thank you.

MR. DUNFORD: Do you have any on helicopters?

MEMBER STETKAR: Yes, I'll get to helicopters. You didn't get to your helicopter slide yet.

MR. DUNFORD: 29, helicopters. So in the evaluation for helicopters, they don't screen out initially, so the analysis was performed to look at effectively the probability of a crash taking a series of data that probably didn't exist so that the engineers made up some - made up, excuse me, crafted, determined -

(Simultaneous speaking.)

MR. DUNFORD: - dealing with the number of flights, size of the angle of the crash and some things like that, and when they did this calculation and documented it in one of their engineering data files, they ended up with a probability then that would say that it was a 10^{-7} order of magnitude 10^{-7} or 10^{-6} using the DOE guidelines.

MEMBER STETKAR: Okay, on helicopters, I know what you did, and there were a couple of different ways of doing it. Regardless of how you do your trigonometry, or geometry, or whatever you want to call it, it finally boils down to your estimates for the annual number of helicopter flights out of those three facilities per year.

Did you have any contact with the people who run those three heliports to find out how many flights per year they actually have? You made an estimate of 1,825 total flights and that you assumed that five percent of the flights pass over the site.

MS. HAASS: They did contact the people, I mean, on the phone. Because the person is not available right now, I will have to go back and ask him exactly who.

MEMBER STETKAR: That for me personally would be a confidence builder because I did a couple of different calculations determining, you know, using the same craft statistics that you used, and came up with a couple of different conclusions, but again, the primary variable is that number of flights. And if indeed it's anchored to some sort of historical evidence or is conservative compared to the historical evidence, that would help me an awful lot.

MS. HAASS: Okay.

MEMBER STETKAR: Thank you.

MR. DUNFORD: Slide 30 is, well, actually the next several slides are the discussion on the airways. So there's seven airways near the site, four that we've determined that were within two miles of the site. Slide 31 then has a chart.

Well, Steve, go back, please. So the airways are actually shown on that chart if you can see them, and there's actually one that runs pretty close right over the top of the site area, so there's obviously airways in the area.

So four of them we then used again the DOE standard as the basis for the evaluation. And on slide 32 is kind of the summary results in a table based on, again, we used the continental United States average values which is a place to start, wingspan and some different data, and looked at it for air carriers, air taxis, military, and general aviation, and when you total those things up, you end up with again a -7 order of magnitude.

MEMBER STETKAR: Here again I know what you did. My only question is - because I couldn't read the picture that you showed before, so I went and looked at the airways. I think you have the distances wrong in reverse for V175 and V178.

MS. HAASS: Where are you?

MEMBER STETKAR: I'm on the -

MS. HAASS: On that one?

MEMBER STETKAR: - slide that we were on.

MS. HAASS: Oh, got it.

MEMBER STETKAR: According to my map of the airways from the FAA, V178/V239 is closer to the site than V175 and you have them reversed. I don't think there's a problem according to the method. I think they're both far enough away, but, you know, just in the sense of accuracy.

MR. DUNFORD: Okay, appreciate that.

MEMBER STETKAR: And you're right. There is one that goes right over the site, isn't there?

MR. DUNFORD: Okay, so the next family of evaluations discussed in Chapter 2 are what can happen on the highway and what can happen in the nearby facilities, so I'll be starting on slide 33 right now.

MEMBER SKILLMAN: Let's go back to aircrafts just for a second. One of the areas that we explored in a prior application was the frequency of an air show where there is intentional acrobatics and assembling performance. Did you query the airports as to whether or not they do intend to have air shows where they would bring in medium sized aircraft to do acrobatics?

MS. HAASS: I did, so, no, they do not plan on having air shows. That's never their intended goal, but I will tell you that because of change in city management and the people who are in charge of airports, I've not queried on that in probably the last 12 months, and I'd be more than happy to go do that.

MEMBER SKILLMAN: I suggest that you might wish to consider that.

MS. HAASS: Yes, but I do know that back in the 2014-15 time frame, there was no plan for having air shows.

MEMBER SKILLMAN: Okay, thank you.

MR. DUNFORD: Back to slide 33, so these are the categories we looked at, explosions, the flammable gas including delayed emission on the flammable vapor clouds, toxics, and fires. Carolyn probably ran through the slide about what's on the road pretty quickly.

MS. HAASS: We can go back though.

MR. DUNFORD: That's okay.

MS. HAASS: There it is.

MR. DUNFORD: Well, I really didn't want to go back to it because there are some things there that aren't necessarily flammable or explode, but they may just be hazardous, so they're not necessarily a one-to-one evaluation as we go forward.

So going then to slide 34 using the I guess what I'll call standard methodology or the TNT equivalents using the heat of combustion, which I believe comes out of NUREG guide 1805 as kind of a comparison of the heat of combustion of TNT versus a chemical to be able to do a ratio.

If you look at that, you'll see from the table the one PSI or I guess it's 6.9 kPa over pressure, for these evaluations, you'll see that they are within or below - the standoff distance is okay. It is pretty close for a couple of those. The propane fire or the propane explosion on the road is, you know, probably only a couple hundred feet difference from that, but that's where those values are at this time.

I do think there is some - if you look at the analysis, I think there are some conservatives on what we used in the size of what could be carried and what could happen. I don't really think you'll see propane in that size of containers, but anyway, we used some standard values in there that were pretty good size.

So that's those set of accidents from explosion, and then the next set of similar explosion accidents are looking at the nearby facilities and the materials stored there and the standoff distances, and there's really two things, I guess, of note in there.

The South Farm, which is the Missouri University South Farm which kind of surrounds the Discovery Ridge site, has, if you look at their total value, they have a lot of propane and a lot of diesel fuel, and if you just use that value by itself, you would find that they would, and as close as the site is, they would be above the standoff distance.

But when you actually go to the next level down and look at while the propane and the diesel are all diffuse locations, it's not a single location, and you go look at it from that aspect, you find out that yes, an individual tank or an individual location doesn't have enough material to contain an issue with the radioactive processing facility.

MEMBER BALLINGER: Is there a way to propagate from one to another?

MR. DUNFORD: In the South Farm, I'm going to say no just because we're talking in some cases they're hundreds of yards or miles apart because the South Farm covers a lot of area, but hold that thought for the next question which is the Magellan facility.

There again if you look at in total mass, it would be within the standoff distance, so we looked at the largest single tank if that had gone off at one time, and then you would end up with a - it would still be okay. So now the question you're asking is how does it propagate?

So if you propagated and the pressure waves were far enough away, and they would dissipate before the next one got there, so we did not do an evaluation that said, "Well, if four things went at once, or three." That has not been done, but it was something that we talked about. We recognized one wasn't going to work.

We built a small discussion I'll say about why that made sense to take the largest tank as opposed to trying to do something that would say, "Well, which tanks are full?" and we used a full tank, and so there's some different things that we did there, but to answer your question directly, no, we did not look at a propagation of one tank.

And that would be a place where you might want to - where you could say that might be something to look at, whereas the South Farm, it's really obvious that you don't need to do that, and I've looked at - say I've looked at South Farm on Google Earth to make sure that I understood that.

MEMBER POWERS: I'm a little surprised for an agrarian area that there's no mention of ammonium nitrate.

MR. DUNFORD: There is ammonium nitrate in the transportation on the corridor. Ammonium nitrate solution is being hauled back and forth. As far as the evaluation of explosion, the ability to get to those conditions that would cause an ammonium nitrate explosion similar to, you know, with a mixture of fuel oil or something like that with it, or some kind of initiator, the folks that did the analysis came to the conclusion that that was not probably from an accident or from an initiating event, it was not brought forward into the screening evaluation.

MEMBER POWERS: There might be people in Texas that would disagree.

MR. DUNFORD: Well, yeah, I understand, that being dust, and it took up quite a large area of the port area.

MEMBER POWERS: Well, in Galveston -

MR. DUNFORD: Galveston, yeah.

MEMBER POWERS: - they blew the hell out of Galveston at one time.

PARTICIPANT: Texas City.

MEMBER POWERS: Texas City.

MR. DUNFORD: Yes, yeah, that's probably closer to a fuel air explosion with dry fuel. So, Carolyn, that's the last of my slides. I'll entertain other questions.

MEMBER STETKAR: So I've read through what you did on the highway. I'm going to focus on the highway -

MR. DUNFORD: Okay.

MEMBER STETKAR: - stuff right now, in particular, the probabilistic analyses that you did for delayed ignition of hydrogen, propane, and ammonia -

MR. DUNFORD: Yes.

MEMBER STETKAR: - and the probabilistic analyses that you did for toxic gas releases of ammonia, chlorine, and sulfur dioxide. Those were the six hazards that you could not screen out just using a standoff distance, so you did a probabilistic evaluation.

I don't know how to put this tactfully,

so I won't. They're wrong. They're wrong in the sense that you are ostensibly quantifying the frequency of damaging events per year and comparing that with an order of magnitude, whatever that means, the 10^{-7} per year frequency. What your probabilistic analyses quantify is the conditional probability per truck. They don't quantify frequency per year.

You're missing the number of trucks per year of each type that traverse the section of the highway near the site. If you want to discuss that, we can discuss it, but the units that you quantify are accident per truck mile times spill per accident times release per spill times ignition per release times miles.

MR. DUNFORD: So I actually had that same though last night as I was trying to bone up on this material, and I went and looked at the reference information which is NUREG CR 6624 thinking that was the same, that I should have multiplied that by trucks, and when I looked at that, and again, this was last night at 10:00, and again, I was second guessing the authors that did it when I did that, but I came to that same conclusion before I looked at that, and it talked about that that applied not per truck.

MEMBER STETKAR: Well -

MR. DUNFORD: So I initially agreed with what you were saying, and then as I looked at the guide, it says, well, maybe it looks to me like it has a different interpretation in that guide, which I assume is what the authors looked at, so -

MEMBER STETKAR: I have no idea -

MR. DUNFORD: - we'll go back and reevaluate that and look at that.

MEMBER STETKAR: I have no idea what they looked at, but I know that you're comparing apples and oranges because your frequency screen of 10^{-7}-ish is a frequency in terms of events per year, and you're not calculating that.

The other thing that you're missing in those calculations is that as best as I can tell, and I'll use the hydrogen one just because I have the numbers here, it has a conditional probability of a release of greater than a certain amount, and it happens to be 0.2 in this particular case.

MR. DUNFORD: Yes.

MEMBER STETKAR: And for that particular release at an exposure distance along the highway, I'll call it, is assessed as 1.54 miles. Now, that 1.54 miles is characterized in the report as applying for a complete release of the truck inventory, and that's okay because in the references that you use, they have a simple three bin histogram of 0.6 conditional probability that you get anywhere from zero to 10 percent release, 0.2 I think it's 10 percent to 30 percent, and 0.2 that it's greater than 30 percent.

The real calculation should look at the probabilistically weighted distances. So if there's a 20 percent probability that it's 1.54 miles, there's another 20 percent probability -

MR. DUNFORD: That it's closer.

MEMBER STETKAR: - that it's a smaller distance, but that should be added.

MR. DUNFORD: Okay.

MEMBER STETKAR: And there's a 60 percent probability that it's an even smaller distance, and that should be added. Those three summations are not made unless that 1.54 miles somehow accounts for it, but I don't know, and that's also - that type of calculation is done is all six of those -

MR. DUNFORD: Yes.

MS. HAASS: Yes.

MEMBER STETKAR: - probabilistic things, so it's not clear to me that you've summed up the probabilistically weighted exposure distances, which for the three - I'll grant you for the three flammable vapor clouds, are pretty small distances. On the other hand, if there's 10 trucks a day that go by there, it's a different question.

The exposure distances for the toxic gas releases are a lot bigger, so missing those other pieces for the toxic gas releases could be numerically interesting.

MS. HAASS: Well -

MEMBER STETKAR: So I'm going to say go back and look at those calculations from both aspects. You know, are you calculating a frequency of damaging accident per year to compare with the screening criteria, and is there a calculation adding up all of the exposure distances -

MR. DUNFORD: Right.

MEMBER STETKAR: - along the highway for the three bin -

MR. DUNFORD: Okay.

MEMBER STETKAR: - spill condition probabilities?

MS. HAASS: We'll definitely take that action and go back and look at that calculation and get you that information.

MEMBER STETKAR: And again, NUREG CRs are contractor reports.

MR. DUNFORD: Okay.

MEMBER STETKAR: There have been many NUREG CRs that have had bad numbers in them, so don't rely on somebody else's error in a contractor report as justification for your units being off.

MS. HAASS: Okay.

MEMBER STETKAR: I didn't go back and look at that NUREG CR.

MR. DUNFORD: It's a PNL report.

MEMBER STETKAR: I don't care who did it.

MR. DUNFORD: Okay.

MEMBER STETKAR: Anyway, just check it, please.

MS. HAASS: We will definitely do that. Thank you. The next item we're going to talk about is meteorology, and so the first thing is, you know, our facility, you know, as I said, is located in Columbia, Missouri. It is defined as, you know, a humid, continental, warm summer climactic zone, which more or less means you've kind of got long, warm summers.

And I will tell you I was there last week, and 100 degrees, and I swear it was 100 percent humidity, but I know it wasn't, but it felt like it. And, you know, fairly cool to cold winters. You know, you rarely get over 100. You rarely go below zero.

But, you know, as stated here, you know, the lowest average temp is around 25 degrees approximately, and the highest is around 85 with the five-year annual temperature around 55. You know, the hottest it's ever gotten there I believe was in 2012 or 2013 and it was about 107 degrees, so it was fairly hot and I'm sure it was fairly humid at the time as well.

Precipitation, they do get quite a bit, much more than I'm ever used to, but on average, about 40 inches. I mean, when you're from Hanford and Denver, you know, you don't get, you know, especially Hanford, you just don't get much over seven inches. So mean snowfall around 23 inches, and they do have definitely a lot of days of precipitation. I always seem to be there on them, but it's over 100 days.

So, you know, obviously they get their precipitation, and obvious it's humid. And, you know, according to the data that we were able to pull, you know, the lowest average relative humidity is around 52 percent, with the highest average relative humidity around 82 percent, and those occur in the August-September time frame, with an annual average of around 70 percent. Sorry, I'm just rounding up on my numbers here.

I think one of the things that we all know, that the heartland of the U.S. is tornado alley and everyone worries about that, but they're not really in tornado alley. They're just north of it. So, you know, and that's lucky they don't have a lot of tornados.

If you look at the seasonal frequency of the tornados of the F-0 up through F-3, there's been very few, and if they do occur, they're in the - it's in the - the only F-3s they've ever had were in the November time frame, and, you know, this was between 1954 and 2016.

And I'll be honest, I don't remember the years that those F-3 tornados occurred, but we got to remember, you know, like Joplin, Missouri, you know, I mean, it's 200 miles away, but that sits in tornado alley. It's just because of how the wind currents come together. They're just - I think they just sit north. I can't remember if Joplin is in Missouri to be honest with you.

MEMBER KIRCHNER: So let me get to the punch line then on this because I peered ahead at Chapter 13. But if we refer back to slide 19, you list some of the principal design criteria there. I know that's Chapter 3.

MS. HAASS: Wait, Chapter 19 or page 19 did you say?

MEMBER KIRCHNER: Yes, 19. So you're projecting against water damage and seismic damage. What are you doing with regard to wind and tornado induced missiles?

MR. CORUM: Yes, this is Mike Corum. We'll be conducting the external events analysis, and we'll take into consideration the high winds, tornados, tornado missiles. From what we've gathered so far, we expect the facility to be seismic limited. So even though, you know, we'll do all of the external events analysis, we fully expect that seismic will dominate and everything else will follow.

MEMBER KIRCHNER: Well, you have again, now going back to slide 11, you've got confinement as an engineered safety feature, so I'm assuming you've got safety related.

MR. CORUM: Yes.

MEMBER KIRCHNER: So you're designing and preparing to construct the facility, have you screened out tornado and missiles as a design criteria?

MR. CORUM: We have not. No, we have not.

MEMBER KIRCHNER: Okay, but you're conducting that.

MR. CORUM: We are conducting that, yes.

MEMBER KIRCHNER: Okay, thank you.

MEMBER REMPE: So I guess I'm still with what Walt was asking. What's the punch line? What force of wind will this facility be able to withstand? This is a construction permit application. Are you going to say what you've decided on before you start breaking ground and pouring concrete? It seems like you would.

MS. HAASS: The information we're going to be presenting for that is in Chapter 3, and I don't have the exact design criteria. I mean, I apologize.

MEMBER REMPE: Okay, because I looked at Chapter 2, the text, and I didn't see it anywhere. I saw a nice tallying of all of the tornados that had occurred, but I was like, but what are you going to do? And I haven't read Chapter 3.

MEMBER KIRCHNER: And I looked at 13, and there's no mention in the accident analysis.

MS. HAASS: Right, so Chapter 2 is, it really is just collecting the historical data.

MEMBER REMPE: And you've done the collection, okay.

MS. HAASS: Chapter 3 goes into the design criteria and what we're going to do.

MEMBER REMPE: Okay.

MS. HAASS: And there is a maximum wind event in there, and I just don't remember what it is.

MEMBER REMPE: Okay, thank you.

MS. HAASS: I apologize for that. The next slide, slide 38, I mean, what I'm really doing is showing data, and it shows the seasonal thunderstorm events in Boone County as well as the hail events. I was actually pretty amazed that they've had four-inch hail before. I mean, that's a pretty big chunk.

MEMBER SKILLMAN: I'd like to zero in on that if I could.

MS. HAASS: Yes.

MEMBER SKILLMAN: This goes back to the comment I made earlier regarding the maximum experience of the site. If you recall my comment about Flip Wilson and all you can drink for a quarter, and where I was going is are you looking at the single event or one that, if you will, is more expansive in terms of the location of the site? This report is dated May 28 of 2017. This is just two and a half weeks ago.

MS. HAASS: I don't know what you're looking at.

MEMBER SKILLMAN: I'm looking at a news report that I saw while I was doing my review for today's meeting, and in the small town of Adrian, Missouri, 104 miles directly to your west, "Grapefruit sized hail like bombs coming into the house. It's bigger than I've ever seen. My dad picked some up too. He said it's bigger than he's ever seen in his lifetime and he's 70 years old."

So I don't know whether this report is about some 70-year-old guy like some of us picking up grapefruit sized hail, or whether this will be relevant to the design of this structure as the gentleman spoke about in terms of protecting what will be uranium material inside your building.

But what's interesting is when I looked through your PSAR at hail, there isn't much information about how you protect your facility, and it seems to me that golf ball - or a grapefruit sized hail storm is a very serious event. I'm not sure we've ever talked about it around the table here.

MS. HAASS: We would agree with you, and in the external hazards model, we do take into account hail. I don't remember if it was an average or it was the maximum for the four inches that they have seen in Boone County. And obviously the hail, if that happened May 28, obviously that's not been taken into account.

MEMBER SKILLMAN: Correct.

MS. HAASS: But, you know, in doing this external hazards, they actually are going back and researching historical data because our data is about two years old or two and a half years old and we need to go do that. And as both John and you have given us, you know, maybe we'll go check some additional, you know, historical databases as well, but we will do that, but it is in our model.

MEMBER SKILLMAN: And I see that you do have an accounting for one incident in the table that you show here on the lower right, so.

MS. HAASS: Right.

MEMBER SKILLMAN: I was just in a way kind of being tongue in cheek to show that even in 2017, there are meteorological events that do need attention as you actually develop your Chapter 3 because that's where this stuff really gets taken care of.

MS. HAASS: Right, and part of it has to do with how, what do you want to call it, you know, I mean, the climatic zone they have and just being above tornado alley, and how all the wind streams come together. It seems to be a fairly good demarcation, you know, of what happens in those two areas, but you are exactly correct. You can have an extreme every once in a while, and we will go back and verify that.

MEMBER SKILLMAN: Let me just ask one more, and it's not shown here and it wasn't on a previous slide. It's alluded to, but it's not there. What is your probable maximum precipitation? If I look at your Chapter 1 of your PSAR, you give averages for precipitation, but I've been involved in a number of applications where we took the time to actually look at the PMP, and for the designers, there was kind of an aha moment when folks realized you could have up to 18 to 20 inches per hour.

MS. HAASS: Right.

MEMBER SKILLMAN: And that's with the downspouts, the gutters, and all of the attributes in the facility to move that water away from the site.

MS. HAASS: We agree.

MEMBER SKILLMAN: But that number at least is not obvious in the SCR and is not obvious as a PMP in your Chapter 1.

MS. HAASS: Right, we do have a one-day max. We didn't do the hourly max.

MEMBER SKILLMAN: But it's the hourly max that will set your parapets -

MS. HAASS: Yes.

MEMBER SKILLMAN: - your downspouts and

your gutters.

MS. HAASS: We agree.

MEMBER SKILLMAN: And I've been involved where when we took a good look at the one hour, we said oh, my goodness. We have under-designed this facility because you can get a surprise in that one hour.

MS. HAASS: I'd have to go back to Chapter 3 to see what we've done in there, and then we'll have to go back to the model that we're using. I've got to assume that somewhere in there we've used the one hour probable max, but I would have to get back with you.

MEMBER SKILLMAN: Chapter 1 is where you kind of laid all of that - excuse me, Chapter 2 is kind of where you kind of lay all that stuff out, and it isn't shown in Chapter 2.

MS. HAASS: I agree we do not have the one hour. We have the one day.

MEMBER SKILLMAN: Thank you.

MS. HAASS: We've got to find geology. How did we do that? We skipped the slide. Oh, there we go, hydrology.

MR. CORUM: Again, Mike Corum. We talk a little bit about the data that was gathered for hydrology and I guess I'd like to frame it in the context of the external events analysis and what's important there to us from that standpoint.

Of course, we're pointing out that there's numerous sinkholes in the area, caves and springs, and there's an aquifer that is also in the area, groundwater depths between 12 and 18 and a half feet. The site is located outside the 500-year floodplain.

But a lot of these taken together from the basis for what we've requested as part of the geotechnical study to be able to effectively do the external events analysis, particularly the flooding, external flooding and also the seismic analysis. Next slide.

MEMBER STETKAR: Mike, you're going to get into a load of stuff here, so let me ask this.

MR. CORUM: Sure.

MEMBER STETKAR: Someone brought up earlier sinkholes. In the PSAR, it says that once you do your more detailed evaluation of the site, that if you find the potential for sinkholes, you'd either excavate the site both vertically and horizontally to remove that potential and backfill with structural fill, or install piers to bedrock to support the substructure if a sinkhole was to occur. How deep is bedrock below this site?

MS. HAASS: It's about 20 to 25 feet

depending where you are.

MEMBER STETKAR: Oh, that's all?

MS. HAASS: Yeah.

MEMBER STETKAR: Okay, I couldn't get it from - I didn't see any - Thanks, that's good enough.

MS. HAASS: Sorry, it's about 20 to 25 feet bedrock.

MEMBER STETKAR: Okay, thank you.

MR. CORUM: Yeah, and that is on the next slide, geology.

MEMBER STETKAR: Yeah, I just didn't see any -

MR. CORUM: Yeah.

MEMBER STETKAR: - contours that I could read anyway.

MR. CORUM: That is an important point. For the geotechnical information, we have requested soil borings and requested that those go to bedrock so we can adequately transmit the wave from a seismic event into the soil and then into the structure properly, and I guess that's about all I need to say about geology.

The next one is seismology on 41. If I - well, it's in the New Madrid seismic zone. I don't think I need to say any more. So seismic will be a very big consideration in constructing this facility, and I think we're overdue for a seismic event in the New Madrid zone already.

MEMBER SKILLMAN: Well, and to that point, you've anchored this application to the 0.2g at Calloway, so you're betting the farm on the appropriateness of the 0.2 at Calloway, and that would be your 100 hertz at a part 100, I think, is what that is.

MR. CORUM: Correct, correct, but we will go back and look at the historical data and see how that fits in with the New Madrid event. I think it was the 7.7 moment magnitude. So we're going to try to be bounding, and if that 0.2 peak ground acceleration is not bounding, then we'll have to take another look at that. As far as -

MEMBER RICCARDELLA: Excuse me, this is Pete Riccardella. And, you know, you may be familiar. There's a fairly large effort going on to update the ground motion response on all of the operating nuclear plants, and the Calloway, their existing SSE does have a peak ground acceleration of 0.2g, but the revised spectra, the revised GMRS that are at least currently being - are more like 0.4g for Calloway.

MR. CORUM: Yeah, we will take a look at

the CEUS SSE database as well. This was based on their previous seismic design, so we will look at the update to that, and currently we are - let's go to the next slide because that talks about what we're doing for seismology.

Currently we're planning on using the spectra, response spectra from Reg Guide 1.60. We feel like that is conservative enough, but again, we're going to consult the CEUS SSE database before we go forward, but our plans are to use that response spectrum in Reg Guide 1.60.

MEMBER RICCARDELLA: And is this detailed in - will be detailed in Chapter 3?

MS. HAASS: Yes.

MR. CORUM: Yes.

MEMBER SKILLMAN: Let me ask a question. I'm building on Dr. Rempe's question early on, and this was the comment that we read that there's going to be this geo report by the first quarter of 2017. Supposing you do your bore holes and you learn to your dismay that you've got Swiss cheese under this proposed site, would that cause you to say, "Hey, we're going ahead with this. We're going to move the place"?

MS. HAASS: First of all, there is some geotechnical work that has been done at Discovery Ridge.

MEMBER SKILLMAN: Has already been done?

MS. HAASS: Yes, and what we're doing is this geotechnical part, we're going to the exact site and we're - the way our scope of work is written, you know, we're wanting to do some additional bore holes, some additional soil samples so we can go verify this other report that we were not the lead on, and that's what we're doing, but we have a fairly good idea of what's already there.

We know where bedrock is. We know the type of soils, but we're going to do some confirmatory analysis, and that's what that is all about, and that's why we've already been able to start the external hazards analysis is because we have that data, and then once we get the new data, we'll be bringing that in.

MEMBER SKILLMAN: So to repeat back what I think you just said, yes, there could be Swiss cheese beneath the site, but right now, we don't think so. We've got enough initial information -

MS. HAASS: Correct.

MEMBER SKILLMAN: - to tell us we can proceed at commercial risk with some amount of confidence?

MS. HAASS: That's correct.

MEMBER SKILLMAN: Copy that, okay, thanks.

MEMBER REMPE: And then with respect to licensing interactions, you're going to go ahead because this information will come after you have the construction permit, and then someday you'll submit an FSAR with all of this information. Staff will review it. If staff doesn't like it, you guys have spent a lot of money, but that's the way the game's going to be played, right?

MS. HAASS: This will be done before the final design of the facility is done and before construction starts.

MEMBER REMPE: Right, but you won't come back to the staff for anything until construction has been completed and you want to ask for an operating license, right?

MS. HAASS: No, that's not true.

MEMBER REMPE: Is there something between that you're going to have?

MS. HAASS: No, we plan on providing that to the NRC.

MEMBER REMPE: And they will review it, so it's like we call it a license condition, but there's some sort of construction condition or something?

MS. HAASS: I don't know if it's a

condition, but we've already told them we would provide that information. When our report is done, we'll provide it to them.

MEMBER REMPE: What's the mechanism if they say, "Oh, I don't like what you did here"?

MS. HAASS: Well, it's not whether they like it or not. I mean -

MEMBER REMPE: What if they find it technically inadequate is what I'm trying to say? There's no - and again, maybe this is my understanding of the licensee -

MS. HAASS: Well, a geotech report is just data, so it can't be technically inadequate.

MEMBER KIRCHNER: There is a Reg Guide for liquefaction.

MS. HAASS: There is.

MEMBER KIRCHNER: I don't know the number off the top of my head, but I would assume -

MS. HAASS: But that -

MEMBER KIRCHNER: - you would use that as a reference -

MS. HAASS: Yes.

MEMBER KIRCHNER: - for your submittal.

MS. HAASS: Correct, I mean, but that's the analysis for that. This is just information that goes into your external hazards analysis. It's data points. It's a confirmatory analysis of the data that we already have, and we've decided to go do more additional site specific geotechnical work.

MR. CORUM: The report will provide us enough information to do a site soil profile, and then from that, we'll be able to do the soil column analysis that we need to really understand the soil profile and the soil movement, you know, over time.

MS. HAASS: And we already have a soil profile and understand those things.

As I said, this is just additional confirmatory geotechnical work we're doing.

MEMBER REMPE: So, I'll ask the staff, I guess, but I'm just curious if -- what the mechanism is that they -- it sounds like there isn't one other than they won't give you an operating license.

Am I missing something, Dick? I mean, I'm not hearing anything. I mean, you're saying, it's fine, we're just giving more data to support things. But, if you look at the draft SE, they said, hey, we're going to have the data by 2017. The data didn't come.

I peeked ahead, I know what the staff slides say. They said it's going to be submitted with the FSAR application.

And so, you may give it to them earlier, but they won't, I think, respond.

MS. HAASS: But, that was also an RAI that they provided and we did come back, I can't remember exactly what we said. And, that's why --

MEMBER REMPE: So, they will evaluate it for adequacy? If they find it inadequate, they would let you know that?

MEMBER SKILLMAN: Let's wait for the staff and hear what they have to say.

MEMBER REMPE: Okay.

MS. HAASS: All right, we're done.

CHAIRMAN CHU: Okay, NRC staff?

MR. BALAZIK: Okay, good morning.

This is Mike Balazik again and myself, Dave Titinsky and Al Adams and we also have a contractor on the phone, Enver Odar, who helped us perform this review in the seismic geology area.

So, Dave will start the presentation on Chapter 2 Site Characteristics.

MR. TIKTINSKY: Thank you.

I'm going to tell you a little bit about the purpose of the looking at the site characteristics is just to develop whether there's sufficient information to perform the review and the finding of no significant likelihoods that would make the site unsuitable for the facility.

So, as you've heard from Northwest, the varieties of site characteristics we're looking at were looked at in this chapter and I won't go through all of them just for time, but the same things that we've talked about that Northwest just presented.

Next slide?

The regulatory basis, we've mentioned this earlier presentation about which parts of the regulations in Part 50 results in us issuing a construction permit.

We followed the guidance in NUREG-1537 as well as the ISG to NUREG-1537 for production facilities.

Since the area's review, which we'll go over a little bit in detail of each of them that were broken up by Northwest, this chapter also provides discussion of external hazards and natural phenomena we'd use as the basis to design the facility, that's analysis.

A little more information here that, as you've heard, Chapter 3 has got the design basis in there and Chapter 13 has accident analysis. And, I think some of the questions that wind up happening is because, again, these crossing the chapters that some of these answers are found in -- hopefully found in other places for your questions.

Next slide?

So, as Northwest has mentioned, it's Discovery Ridge Research Park in Columbia, 7.4 acres then the area of the population is generally centered around the City of Columbia as most of the people within five miles.

Next slide?

Okay, so how we did the review, so the staff performed an evaluation of the siting information presented in Chapter 2 of PSAR, again, emphasizing a sufficiency of preliminary design and performance of the facility in support of the construction permit.

So, again, the sufficiency of the design is really what's important here is to provide enough information for us to be able to make the regulatory conclusions that are necessary for a construction permit.

So, these areas, I'll be going through each of them individually for what the staff had looked at.

Let's go to the next slide.

So, the geography and topography, so the PSAR talked about the distances in relation to boundaries, roadways, waterways and other significant features. They were looked at by the staff using some third-party supplied maps, some Google Maps.

We note some of the questions that were brought up with some of the locations from ACRS members that we'll evaluate whether they have any impact on when they give us the answers and the impact on our findings.

But, based on the distances and what was provided in the PSAR, the staff looked at where the nearest resident, it was about three-tenths of a mile from the site.

So, the staff findings for this section were that the level of detail was adequate to provide an accurate description of the geography.

The demographic information was sufficient to allow an assessment of potential radiological risks for the public from the facility.

Reasonable assurance that no geographic or demographic features render the site unsuitable and the findings are consistent with what we looked at in the staff's final Environmental Impact Statement which Mike had mentioned. It was issued in May of this year.

MEMBER SKILLMAN: Dave, to that point, and, Joy, this is the second bullet from the bottom is the answer to your question.

MEMBER REMPE: Well, read the last slide that we'll be getting to later, there's more.

MEMBER SKILLMAN: Okay.

MEMBER REMPE: There's some more coming on that's the answer to my question.

MEMBER SKILLMAN: Yes, yes, okay.

MR. TIKTINSKY: Yes, so this just, you know, we make individual findings on the individual sections then we make an overall finding for the chapter and hopefully it will answer any questions that you have.

So, the nearby industrial, transportation and medical and military facilities that staff concluded that the hazards proposed by these have been described an analyzed to the extent necessary to evaluate the potential risk.

The applicant evaluated risk from aircraft and heliports and determined, based on the guidance, that those were within the order of magnitude of 10 to the minus 7 and no additional analysis were needed.

Again, we note that the discussions that were had earlier --

MEMBER STETKAR: Dave, let me ask you, I'm not going to repeat what I asked earlier, you heard it, it's on the record, I don't need to drive that home.

On the other hand, this notion of the order of magnitude of 10 to the minus 7 per year, if I look at what they have in their report, for example, for aircraft crashes, and I'll call aircraft as anything that flies in the air, in one section of the report, they quantify a frequency of helicopter crashes of 9.7 times 10 to the minus 7 event per year. And, we talked about that earlier.

And, in another section, they quantify a frequency of airplanes falling out of the sky of 7.3 times 10 to the minus 7 event per year.

So, I add those two together and things falling out of the sky hitting the facility is 1.7 times 10 to the minus 6 event per year.

That's still an order of magnitude of 10 to the minus 7?

MR. TIKTINSKY: Yes.

MEMBER STETKAR: Okay. So, if I add up like 30 of these different things and get up to, you know, like 7 times 10 to the minus 6, is that still in order of magnitude of 10 to the minus 7?

I mean, I can parse these things down into as many little sub-pieces as I want, but if I add up the total risk, eventually, it gets up to something that I might be interested in.

So, how do you make this determination of on the order of magnitude of 10 to the minus 7? To me, that says sort of, kind of 10 to the minus 7, it doesn't say a couple times 10 to the minus 6.

MR. TIKTINSKY: I'd have to go back and look at what the methodology of NUREG-0800 --

MEMBER STETKAR: Oh no, no, I'm not arguing with the methodology, I'm questioning how you folks, now the staff reviewers, add things up to determine that the total risk is of the order of magnitude of 10 to the minus 7 damaging events per year.

MR. TIKTINSKY: Well, I guess in this case, for aircraft, we were looking at what kinds of aircraft, based on what's in the vicinity of the facility. And, we didn't have any information about anything else.

So, even though you could have added 30 things together, but if there were 30 things together then we would have done that.

MEMBER STETKAR: My point about 33 things is focusing on the two specific things that I mentioned, those are the two things that they evaluated. Those are the two things that you made your finding on.

Your finding is that something of the order of 1.7 times 10 to the minus 6 event per year is of the order of magnitude of 10 to the minus 7 event per year.

To me, it's about 20 times higher than 10 to the minus 7 per year, 17 times higher.

At what point does it become not of the order of magnitude of 10 to the minus 7 per year? Does it have to be 30 times higher? Does it have to be 70 times higher? Does it have to be 200 times higher? What are your criteria for making that finding that it's small enough?

MR. ADAMS: And, I don't think we can answer that question right now. We're going to have to take that back and get back to you.

MEMBER STETKAR: I've always had a problem of this -- of the magnitude of 10 to the minus 7 per year because I think that members of the public would interpret that that it might be a couple times higher, it might be a few times lower.

But, certainly, if it's lower than that, there's no concern, at least according to the guidance.

But, at some point, it becomes big enough to not be of the order of magnitude --

MR. ADAMS: Well, I agree with you. We're going to have to go back and do a little bit more research into what NUREG-0800 is --

MEMBER STETKAR: Yes.

MR. ADAMS: -- exactly getting to and this is where --

MEMBER STETKAR: Yes.

MR. ADAMS: -- the order of magnitude is -- that gives you a lot of maneuvering room if you want it, but does that, you know, does that make sense evaluating?

MEMBER STETKAR: Okay. I was just curious whether you had some sort of thumb rule. Okay, thank you.

MR. ADAMS: We might, but I can't articulate my thumbs at the moment.

MEMBER STETKAR: Okay. Thanks, Al.

MR. TIKTINSKY: Good, next slide, Tom?

For meteorology, the staff concluded that there was sufficient meteorological data to provide -- to support the necessary analysis, including the prediction of frequencies or occurrence of intensities of severe weather conditions.

We looked at the data, confirmed it from an independent source that it was reasonable for, at least for 2013.

Might want to note that, you know, the -- when PSARs are submitted, obviously, this was submitted in 2015, so there, obviously, was data that was developed, you know, prior to that.

So, you know, applicants are always responsible eventually for either, you know, if something -- new information changes their conclusions for putting that in.

And, in this case, for the operating license if something in the operating license is significantly different from what they presented in the PSAR, they would have to provide that analysis and then its impact.

So, the staff had found for meteorological history that the projections were acceptable and they'd be factored in the choice of facility location and design.

And, again, a lot of the details of this are found in other chapters.

But the information's sufficient for analysis commensurate with the facility risk and the methods are applied -- methods of assumption are applied for releases from normal operating and postulated accidents as you'll see when we get into discussion in August of Chapter 13 which has the accident analysis.

MEMBER KIRCHNER: So, at this point, I looked ahead at 13 to see if tornado missiles are included and they are not. I think the applicant is looking at wind modes and we heard them or at least point to some concern on their part about their confinement boundary and, you know, I'm not sure where that boundary exactly is for their stack and, the wind loading on that was mentioned earlier this morning.

But, what is the requirement here since this is not a power reactor, do you still go back to Reg Guide 1.178 and look at tornado induced missiles?

MR. TIKTINSKY: Well, the Chapter 13 analysis is the results of the ISA. So, they had to go through every event that could have intermediate or high consequences based on --

MEMBER KIRCHNER: I don't think it's there.

MR. TIKTINSKY: -- 7.61. So, if they've determined -- if it's, generally speaking, if it's not in the analysis they don't then require IROFS, then their determination is that it didn't meet any of those criteria.

Now, Chapter 3 lays out what's called the design inputs which are the codes and standards and other things which is one of the things that, you know, we'll definitely re-analyze here.

But, in -- it is extremely important for the operating license of exactly what codes and standards they're meeting to actually design the facility.

So, they had to analyze -- on of the other things that I guess, and make sure, yes, we talked about, you know, is the design criteria that so, even though the criteria in Part 50 don't apply, Northwest has chosen to follow the baseline design criteria for -- that are in Part 70 which include things like tornado missiles.

So, they have to be evaluated in their evaluations.

MEMBER STETKAR; Dave, I, unfortunately, am not real familiar with all of the Reg Guides and the NUREGs and stuff.

You mentioned the regulatory guidance for these types of facilities requiring -- well, Reg Guides don't require -- mentioning tornado missiles.

In recent years, it's come to light that straight line wind driven missiles can be more damaging than hurricane missiles and tornado missiles.

In particular, the emitting missiles for commercial nuclear facilities along the Southeast Coast of the U.S. are determined by hurricanes, they're not determined by tornados.

The applicant showed a slide that's quite interesting that about three to four times a year on average at the site over the last 60 years, Lunk has experienced greater than hurricane force winds, straight line winds.

So, it's not clear to me, necessarily, that only examining tornado missiles would provide the most bounding missiles for the structures. They might, indeed, be driven by straight line missiles.

Especially given their experience with relatively modest amounts of tornados that, surprisingly, but relatively modest tornados at that location.

And, I don't know what the regulatory guidance says about that. I mean, historically, it's always been tornados, tornados, tornados.

MR. ADAMS: As far as research reactors go, there -- it doesn't say an awful lot. As part of our Fukushima work, University of Missouri Columbia that didn't screen out from a top level view.

So, we did look at tornado missiles and that facility. So, I know at least we have a determination of what the entry conditions are, you know, what type of wind and, you know, I think it was your Schedule 40 pipe and --

MEMBER STETKAR: Yes, yes, yes.

MR. ADAMS: So, there was, you know, there is some work in the neighborhood that might be worth taking a look at to --

MEMBER STETKAR: Okay.

MR. ADAMS: -- to look at, you know, are we bounding this properly?

MEMBER STETKAR: Okay, thanks.

MR. TIKTINSKY: Next slide?

So, the next section of hydrology, and here, the staff concluded that the applicant provided sufficient information regarding the general hydrogeological characteristics of the proposed site to allow an independent review.

The staff finds that applicant considered the events, credible frequency and consequences, that the applicant considered credible events in developing their design basis for events in Chapter 3 and that the ISA evaluated accidents related to hydrological events, that finding a reasonable assurance that performance requirements of 70.61 which are not mandatory for this facility, but are being chosen by the applicant to be used can be met as shown in the ISA summary.

Also, I'll just note that the site's located outside the 500-year flood zone and that there are no dams or impoundments upstream.

Of course, we did have discussions of short-term hourly events which the applicant will address and we'll see if that has any impact on their ability to meet the performance requirements.

MEMBER STETKAR: David, I promised myself that as long as I'm sitting here, I always have to ask this and this is the staff's word, it's not the applicant's word, what's a credible frequency?

MR. TIKTINSKY: So, the applicant defines events in terms of what events are likely, highly unlikely and their definition of credible and noncredible.

So, that the definitions, if you get it from the Part 70 methodology, the Part 70 specifically doesn't define those terms. It's up to applicants to define those terms.

So, in the light of what's credible is that the definitions that provided by Northwest of what was a credible and noncredible event --

MEMBER STETKAR: I'm sorry, I just searched Chapter 2 and, other than citing a quote out of NUREG-5020 in one sentence, the applicant has not used the word credible.

You, the staff, have said that they have demonstrated that there's not a credible frequency of these events. So, this is your conclusion.

MR. TIKTINSKY: Yes, so the definitions of what is a noncredible event, I'd have to look in their PSAR to see where they've defined that. But, that's part of the definitions that they do under a 70 methodology is defining those events.

MEMBER STETKAR: Okay, thanks.

MR. TIKTINSKY: Next slide?

Geology seismology and geotechnical engineering, here, the staff concluded the applicant provided sufficient information regarding the regional site geology, seismicity, earthquakes, ground motion, surface faultings to allow independent review.

That the applicant provided sufficient information on the features for the potential seismic activity.

Seismic events were evaluated also and then the ISA and they're discussed in Chapter 3.4 of the PSAR, so we'll get to the details of that when we talk about Chapter 3.

Also, the finding related to no significant likelihood that the public be subject to undue risk following a seismic event that would make the site unsuitable.

As is noted, the additional geotechnical analysis determined liquefaction potential is being developed by the applicant and will be submitted with the operating license application.

I think you had asked the question before about when --

MEMBER REMPE: But that was this slide, yes.

MR. TIKTINSKY: -- when things commence. So, assuming we make a finding to issue a construction permit with a PSAR, the next document that's submitted officially to the NRC review is the final safety analysis report with the operating license.

So, if there is something in the documents that they find between the PSAR and the FSAR that makes the site unsuitable or something else, it's not an official NRC review and a finding of that document that's sent in. It won't be until we receive an operating license application.

MEMBER REMPE: So, they -- and that's why I was trying -- kept harping on this that, yes, they'll do this. They think it's great, but you don't really officially look at it and respond back until they ask for their operating license and there's no mechanism --

MR. ADAMS: So, you know, we haven't had a lot of -- you know, we haven't done this a lot, you know, China was the first one.

But, I would believe that if they came in and said this is significant to our design, this is important, and, you know, asked can the NRC staff review and give us, you know, give us a finding? My guess sitting here is that we would try to accommodate them versus having that level of uncertainty continue until the end where we would go, guess what?

That's not the goal here.

MEMBER REMPE: That was my cart before the horse comment --

MR. ADAMS: Right.

MEMBER REMPE: -- at the beginning of the day here.

MR. ADAMS: But, you know, on the other side of the fence, you know, I don't want to get two letters a week saying, you know, look at the, you know, look at the color of the paint and look at this and look at that.

So, you know, we, you know, we need to figure out how to move forward. And, like I say, you know, we haven't cross the Part 50 construction threshold in a long, long time.

MEMBER REMPE: The other point I'd make is your draft SE says that the state is coming in the first quarter of 2017 and things have changed. And, are you going -- I mean, this is the only time that I've seen anything official from the staff that says we don't have that data.

And, are you going to update the draft SE saying we didn't get it when you issue your construction permit and make it obvious that, in your list of things that are standing out, that it'll be there?

MR. BALAZIK: This is Mike Balazik.

Yes, we'll make sure that our list of outstanding things that that will be there. We will update the PSAR.

We were anticipating getting this report before the --

MEMBER REMPE: Right.

MR. BALAZIK: -- before the final PSAR. But, I mean, I'm sorry, before a decision on the construction permit. But, it doesn't look like we're going to get the information. So, we will update that that we expect to see this information later.

MEMBER REMPE: Thank you.

MEMBER SKILLMAN: Let me make this comment. The SER that we were provided is an anticipatory document. It is written as if a lot of things have been provided when, in fact, some have not yet been provided.

So, as Joy points out, this is really an optimistic draft of what's going to come. So, at some point, this needs to be updated to be accurate for what really has been provided and what your assessment is of that.

Let me give you an example and I think this is important. This is on your SER page 2-9. You make this comment, this is about situation where the plant's been shut down for a long time, this RPF.

After a long outage, the water run test would typically be performed to check the equipment and processes.

That's written from the perspective of a plant that, if you will, has been fairly well vetted. It's up, running, pipes, pumps, valves, heat exchangers, control systems doing what they're supposed to do and it's been idled.

So, this paragraph is pointing to a future condition that, at this point, is just an imagination. Correct?

MR. ADAMS: Where are you at?

MEMBER SKILLMAN: It's on your SER page

2-9, site characteristics. It is the middle paragraph, last sentence.

It is, after a long outage, a water test run would typically be performed to check the equipment and processes.

That's a sentence that's written anticipating, if you will, a healthy startup and test program and a successful run of these processes.

MR. ADAMS: I see what you're looking at. I agree with you. I believe all we were doing is quoting the licensee or the applicant.

MEMBER SKILLMAN: But, this is your document, not their document. You're saying this is going to happen. Okay?

MR. ADAMS: I understand what you're saying.

MEMBER SKILLMAN: So, okay. We're trying to get comfortable that you're comfortable that your review has really vetted this design. That's my point.

Okay, thank you.

MR. TIKTINSKY: So, the overall findings for Chapter 2, the findings for 50.35 related to the RPF systems described including the principle architectural engineering criteria that further technical design information, they have left for later in consideration of the FSAR.

And, reasonable assurance that, based on the review, the proposed facility can be constructed and operated without undue risk to health and safety to the public.

So, these are the general findings that we have for each chapter.

That's all the slides. Any questions?

CHAIRMAN CHU: Any questions?

And, Pete? First, let me ask Pete. Pete, do you have any questions?

MEMBER RICCARDELLA: No, I think, you know, at this stage, it's very difficult to do much review of the seismic until we see the --

CHAIRMAN CHU: Yes, okay, thank you.

Any other questions?

(No audible response.)

MEMBER BLEY: Are we closed after this?

CHAIRMAN CHU: No, we have public comment later in the afternoon.

MR. BALAZIK: This is Mike Balazik.

Just real quick, I just want to go over some of the takeaways that I documented to make sure I captured them accurately.

Ten to the minus 7, kind of defining what order of magnitude means. And, we'll take a look at that NUREG-0800 to help inform our answer to you on that one.

Information to look at for tornado missile, hurricane winds, and we'll take a look at the MURR Fukushima lessons learned to see some of the inputs that they used.

Definition of credible frequency, we'll get back to you on that.

And, Skillman, we'll take a look about that comment that we made understanding on 2-9.

Just kind of updating the PSAR, it goes with Dr. Rempe's comment, too, on updating the PSAR. We'll take that action away, too.

MEMBER SKILLMAN: Yes, plus hourly PMP.

MR. ADAMS: We took note of the comments you made.

MEMBER STETKAR: You know, you're create a checkbox thing here. I didn't want to beat the reviewers up in the fact that you had no credible review whatsoever of the things that I brought up with the applicant that's now on the record.

MR. BALAZIK: Sure, understand.

CHAIRMAN CHU: Okay --

MEMBER KIRCHNER: I would like to, not to belabor, but using the applicant's information and looking at slide 37, and this is tornadoes again or high winds, or both, you have three force three or Fujita Scale three events in the last 60 years.

That, seems to me, to indicate that there's a relatively high probability of a significant tornado in Boone County.

Then, when I go to Reg Guide 1.178 or 1.221 which is hurricanes, I would assume you would then start looking at missiles and, in the case of hurricanes, they looked at things like automobiles and other objects that cause more widespread damage perhaps than a single penetrating missile.

So, I'd just flag that because I have looked, I'm repeating myself I suppose, Chapter 13 doesn't currently address any accidents that are tornado-induced missiles or hurricane force objects.

Thank you.

CHAIRMAN CHU: We're trying to catch up to time. So, 40 minutes of lunch, we'll come back at 1:00. Is that enough, 40 minutes? Okay, eat fast.

Thank you.

(Whereupon, the above-entitled matter went off the record at 12:20 p.m. and resumed at 1:03 p.m.)

CHAIRMAN CHU: The meeting resumes.

And, now, we're going to start MWMI doing Chapter 4.

MS. HAASS: So, just to preface this chapter, I know we're going to have 45 minutes or so on, you know, on a private session where we're going to go into great detail, obviously, on Chapter 4.

And, what's here is what's very similar that we gave to the full ACRS on May 5th because you guys wanted to understand what we were about.

And so, you're going to hear some overlap. Hopefully, we'll make up some time here. But, we will go into details after we do Chapter 5.

So, this first slide, well, slide 45 is the site plot plan. What this is giving is a bit more detailed than you've seen from Chapter 1.

You're seeing where the production facility is. We're calling out, you know, the admin and all the buildings up in the upper left hand corner, whether it's the fuel tank generator house, the first water storage tank, if we believe it's necessary.

They're going to be doing that water test I believe in the next 30 days or so to see if we actually need that.

And, the waste management building and you can see where the set backs are and those types of things.

In the lower right hand corner, you're seeing where we have the entrance into our facility and where the gate will be.

So, next?

We went over the primary assumptions earlier today, but, you know, we're going to have one single radioisotope production facility that will be based in Columbia and Missouri.

We're going to be using LEU and it will be a fission based method to make our moly with the nominal capacity of 3500 and a search capacity, if necessary, of an additional 1500.

We're going to use the network of university reactors.

Key thing, we are going to capture all our fission product. Well, they will be -- comply with environmental release criteria.

And, we're not expecting to generate any greater than Class C waste. That would be very difficult for us because right now there isn't any storage facility for that. So, that's key for us.

MEMBER SKILLMAN: Carolyn, on each of these slides, you identify six day curie, six day curie. Does that denote a six-day work week? What does --

what is that telling us? What does that mean?

MR. REESE: Do you want me to do it?

MS. HAASS: Yes, it's confusing.

MR. REESE: I personally would like to have words with the person that came up with this unit because it's confusing.

But, what it is, it is the curies six days later.

MS. HAASS: After EOI.

MEMBER SKILLMAN: Oh.

MR. REESE: No, after --

(Simultaneous speaking.)

MEMBER SKILLMAN: So, if they --

MR. REESE: Six days --

MEMBER SKILLMAN: If they weren't at there, that would be more --

MR. REESE: The actual number is a lot higher.

MEMBER SKILLMAN: At a lot --

MR. REESE: The curies is about four times higher.

MEMBER SKILLMAN: At EOI?

MR. REESE: At EOI.

MEMBER SKILLMAN: But six days later, it's decayed to that one-quarter?

MR. REESE: That's correct.

MEMBER SKILLMAN: Okay.

MR. REESE: And, EOI stands for End of Irradiation. Some people call it end margin of EOB. And, I think it comes from the processors wanting to know how much it was going to be a week later for the hospitals, I think that's the origin, but I'm sure.

MS. HAASS: And, by the way, you know, in our document, we don't use six day curies, just to let you know. Because we -- then we'd have to be backtracking, but we don't.

MEMBER SKILLMAN: Thank you.

MEMBER KIRCHNER: That's in reference to moly-99?

MR. REESE: Yes, that's correct. So this is the way the industry talks about activity of columns, so on and so forth at hospitals.

MS. HAASS: The next slide, slide 47, is a layout of our facility. And, what you're seeing here is, you see the light blue which is where our Part 70 license will be at the top. That's the target fabrication area.

You see where our waste management is, where we bring our targets in just below waste management, a utility area.

I think the key thing is, is, you know, you're starting to -- you have the tank hot cell are and just to the bottom and to the left of that, you're seeing where our hot cells are and we're going to be going over that in detail with you.

And, we have a laboratory and chemical makeup area as well.

Just from a general facility description, it's about 52,000 feet on the first level which includes everything you just saw in the previous slide.

There is a basement area where the tank hot cell is and decay vault.

The second level is where we have our utilities, ventilation and off-gas equipment above. You also will have your crane, you know, which will go over, you know, your hot cell area and be able to move cover blocks, those types of things.

As discussed earlier, we have some out buildings. We have a waste management building that's about 1200 square feet, the admin building which is going to be outside the secure area about 10,000.

So, what's the key things? The roof height is 65 feet with the stack being 75.

The mechanical area sits about 46 -- is about 46 feet above ground. And, I'll show -- there'll be some diagrams coming up at the end.

And then, our depth below grade of the hot cell and where our HIC storage is is about 15 feet.

As we stated earlier, bedrock sits around -- I'd need to go find the number exactly, but I think it's around 25, 30 feet and I will go find that.

And, you know, everything we have seen to date, you know, we don't see any issue from soil or bedrock perspective. But, yes, we are still going, you know, we have to go do our seismic evaluation on that.

As I went over this earlier, you know, there's five main parts to our business model. We have target fabrication, irradiating the targets in the reactor.

Then, we bring them back and we disassemble them. Well, we receive them, we disassemble them, we dissolve them.

Then, once we get through the dissolution, the primary mission is to go recover that moly as quickly as possible because time is money.

And then, we then go into the uranium recovery and recycle and it goes back into the target fabrication.

So, everything is in house but the

irradiation. I think we all know that.

MEMBER POWERS: I know you talked very enthusiastically about your experiences with dissolution. And, lots of people have a hard time with dissolution, especially when you're using re-irradiated material getting an accumulation of stuff that, in theory, dissolves and, in practice, kind of doesn't.

What I didn't see in looking at your description of your process is how you assure you don't get an accumulation in the dissolution tank so stuff that just kind of defies dissolution.

MR. DUNFORD: Are you looking at me?

MS. HAASS: Right, these are process ones.

MR. DUNFORD: Okay, so our experience is that what we've been saying dissolves, obviously.

If you ended up with an accumulation, you do two things. We have measurements in and sampling out. So, it would be part of our -- if it's a small amount, it'd be part of our accumulation term that we would handle -- recognize as part of our MCNARM fuel control and accountability.

As far as a criticality concern, we would evaluate it a very -- something that's probably about two or three times what we would ever put in could accumulate in the dissolver.

So, we have a filter or a strainer on that line right now in the PSAR. So, it's part of the recirculation, it's part of the sampling.

We have actually identified as a flow sheet value a nominal of about a half a percent, quarter of a percent as losses that end up in the waste.

We obviously want to minimize that, but that's kind of where we're at right now.

MEMBER POWERS: Well, in truth, I was interested in the accumulation at the bottom of the tank and the dissolver itself.

MS. HAASS: In the plastic as well.

MEMBER POWERS: Yes, I understand that, I understand.

But, as long as you bring it up, can we run this -- is this flow that you look like has been run through ASPEN?

MR. DUNFORD: No.

MEMBER POWERS: Is there a reason not to other than ASPEN's expensive to use?

MR. DUNFORD: They only want $25,000 a quarter for a license.

MEMBER POWERS: It's about $25,000 of contact hours is what it is.

MEMBER BLEY: For those of us not in the know, tell us what that is.

MEMBER POWERS: ASPEN is a chemical process of flow --

MR. DUNFORD: It's a model.

MEMBER POWERS: It's a model --

MR. DUNFORD: Yes, it's a program for modeling.

MEMBER POWERS: It's very good and usually, I mean, we did the MOX facility. We went through the ASPEN calculations. It's very good because it allows you to easily do internal balances and check design alternatives and things like that.

And, it's gotten to be --

MR. DUNFORD: It's a property call, it can be very handy for complicated streams.

MEMBER POWERS: Yes, I mean this particular stream is very similar and I always find ASPEN results useful, but you're right, it's very expensive to use.

MR. DUNFORD: That was Ron that said that, not me.

MEMBER BLEY: I have it as an academic where he used it.

MEMBER POWERS: It is very expensive. I

mean, they're a little cheaper now on letting you set up your models. They don't count that as a contact hour. But, it's still expensive. It's useful to check things and especially since it's pretty good at telling you, well, you did it this way and it'll work this way, but there's a better way to do this.

At any rate, that accumulation of -- I think you know as well as I do that after you zap these things, slowly you get -- you get stuff that you have to put HF in to get it to dissolve. You have to iron in to get it to dissolve. It's just slow to dissolve.

As I look at your stream, you're going to get an accumulation in your dissolvers of stuff.

MEMBER REMPE: So, I guess I have -- I'm not as knowledgeable as you are, but I was wondering, too, about deposits on surfaces and is there a process that you wash those deposits off between different targets that you dissolve from difference reactors or is there a monthly cleaning?

Because that would affect heat transfer characteristics of these things, too, as well as concerns about criticality. I mean, I just was curious. I'm not experienced with this type of thing.

MR. DUNFORD: Yes, so, the somewhat good news is that this -- our slow center endpoints are fairly dilute.

So, what we have evaluated as off normal conditions as part of all the PAH as far as precipitation and some stuff happening, in the current nominal flow sheet, we have to do flushing. After transfers, we do flushing after transfers.

We have parts in the system that we actually replace after -- as a single use. And, we have other parts of the system that would either be part of some quarterly evaluation or whatever the frequent evaluation is going to be required for our MCNA material accountability.

But, typically, so far, the things we have seen, the data we've seen, the experience we have from literature and from processing is we're not expecting that.

I mean, I grew up in the waste arena where it's kind of a witches' brew of everything. And, the chemistry, going back to what you were talking about, the waste treatment or that plant in the northwest, that issue is because you can't characterize what the material's going to go on to it.

So, you try to make up for the worst case and you can't -- you can never design something for the worst case in that particular worst case because somebody else can think of something worse that you just thought.

So, for this facility, there are -- there's plant flushing. We really don't expect to see a lot of precipitation and build up because of the conditions we're operating in.

But, obviously, those would be things if we're start -- if we see that, we would have to have a protocol for changing out pipes, changing out skids or whatever if there was something that couldn't be handled in place.

MEMBER POWERS: You actually have things you change out after every use?

MS. HAASS: Yes, and that's where I was going to go. The reason we have to do -- change out certain things after use has to do with some of the lines because of the FDA requirements.

Once we get into the moly purification area and it just has to do with FDA and clean and being clean and so you always want to replace them after every use.

I mean, yes, it can get expensive, but I mean, you're using something like peak 2 being something like that when you get to -- when you get down to the purification.

And, you know, that's what we're doing in our R&D, we use this peak 2 unit and we know how to go in and do that with manipulators.

And, you know, it's a little bit of time, but, you know, you've got to clean up anyway. So, but --

The next six or seven slides take each one of these boxes and we're going to go through it at a high level. And, as I said, we'll go through it in more detail in a bit.

Steve?

MR. REESE: This is me, correct?

MS. HAASS: Correct.

MR. REESE: All right so, I'm Steve Reese, I'll be taking over for the next few slides.

So, what we're really talking about here is Step 1, what we're describing here is the cell gel process essentially. So, this is how the target material is made.

So, in a nutshell, what you're basically doing is taking uranyl nitrate, concentrating it, cooling it and then you're -- I don't know if you've seen this, but essentially, you drop it, literally drop it as drops into a cauldron of hot oil.

And, what happens is as that -- oh, I'm sorry, I should have said we mix it with an organic such that when it follows through the boil, the organic pulls off for most of it and you get this really, really, in an ideal world, and it works pretty well it turns out, a sphere. So, it falls out the bottom as this sphere.

And then, what we're obligated to do is clean it after that and I believe, do I get into -- yes, yes, yes, okay.

So, this is the entire cell gel process.

So, after it falls out, we'll wash it, clean it, dry it and then we'll -- it's UO3 at that point. And then, what we will do is we'll put it an oven in a hydrogen atmosphere for a prescribed time and out pops the target material that we will be using.

Now, there's a little more detail to go into this afternoon. It's a little bit of this process you can -- it's widely available in the literature.

What's interesting is that it's a little bit like a cooking recipe. You can read the recipe, but sometimes it doesn't come out the way you think it does so it takes a little bit of practice.

Going to the next step, encapsulation. So, after we are -- we do the QA/QC on the target material itself, what we're going to do it put it into the hardware. And, the hardware is pretty simple and we'll spend -- I'll provide you some intricate details this afternoon. We'll go through the target itself in nauseating details as it were.

But, the target will be -- will have a helium cover gas. So, it will be backfilled with helium and sealed. And then, we'll do appropriate QA/QC on dimensions and also helium leak tests on it to make sure it is sealed, appropriately welded and sealed appropriately.

And then, we'll essentially use the ES-ES-3100 shipping cask to load them in the cask and send it off to the reactors for irradiation.

MEMBER REMPE: But how is it to weld these things? Does it make the material brittle? Are you doing to do destructive testing to qualify your welds or just the leak testing?

MR. REESE: We're -- our intent right now is to do -- essentially, we're going to -- the thing we're going to rely on most is visual inspection and maybe dye pen and then, I'm sorry, not the most but the first thing to do is visual inspection and maybe dye pen.

But the most important thing we're relying on is the helium leak test.

MEMBER REMPE: Is it automated or is it

a person doing it?

MR. REESE: No, it's a person, yes, which is how it's essentially done now.

MEMBER REMPE: That's a lot of targets to make a person do that. I mean, they don't even have some sort of machinery that helps facilitate it?

MS. HAASS: It does exist out there and I mean it's something that we're --

MEMBER REMPE: So, something exists out there --

MS. HAASS: Oh, yes, yes, yes and --

MEMBER REMPE: Yes, I've seen it. It's something to think about and that's a lot of --

MS. HAASS: We agree.

MR. REESE: You mean on the leak test or the welding?

(Simultaneous speaking.)

MR. REESE: Oh yes, you can set that up such that --

MEMBER REMPE: -- testing you should have QA to make sure you're at least --

MR. REESE: Yes.

MEMBER REMPE: -- certified and all that stuff. But, I think --

MS. HAASS: We agree.

MEMBER REMPE: -- an automated welding --

MR. REESE: Yes, yes, that's --

MEMBER REMPE: -- smarter I think.

MS. HAASS: Yes.

MR. REESE: I thought you were talking about the leak test, sorry, yes.

MEMBER REMPE: Yes, I was -- no, no, I'm -- yes, you are planning then to have automated --

MR. REESE: Oh yes.

MEMBER REMPE: -- welding and you'll do some testing to make sure --

MR. REESE: Yes, yes.

MEMBER REMPE: Okay.

CHAIRMAN CHU: Question.

MR. REESE: Yes?

CHAIRMAN CHU: Is this LEU target commercially available or are you still on these --

MR. REESE: They're our own design.

CHAIRMAN CHU: Okay. Because I know a lot of people are working on it and --

MS. HAASS: Exactly, there are a lot of people working out there on this type of target, but they're not our target, though and that's why we're --

CHAIRMAN CHU: I know, I know, so it's not available?

MR. REESE: Part of the problem is that everybody else, the controversy over the HEU to LEU for a moly is the fact that they've been running for 50 years with HEU and they have to change their process.

We're starting the process with LEU so we don't have some of those technology issues on an existing infrastructure. We're creating our own infrastructure off the LEU to begin with.

CHAIRMAN CHU: Okay, thank you.

MEMBER SKILLMAN: What is the pressure, the internal pressure of the target container after it has been closed with the weld?

MR. REESE: It's essentially atmospheric.

MEMBER SKILLMAN: Okay, thank you.

MR. REESE: And they are transported.

The other thing just to stipulate is, and we'll talk about this more this afternoon, but we're recycling the uranium target material, though, correct.

So, we have to delay or let the uranium solution decay long enough such that it is our intent that everything will be contact handleable, so, we're not looking at anything that's going to be putting off a significant dose rate. So, that's the intent.

So, everything that moves from that Part

50 side -- because what I'm really talking about here is what's happening on the Part 70 application to be honest with you.

So, and as the staff correctly identified this morning, we have been very forthright and telling them what's going to be happening on the other side of that wall because it does educate them about how the relationship between the two licenses will need to be handled. This is an example.

So, we're anticipating the target material to be contact handleable.

On the other side, after irradiation, so it's going to be received in the facility and I'll walk you through where and how this will happen on the diagrams this afternoon.

But, essentially, we'll remove the cask off the trucks, move the casks over and we will pull the targets out of the casks, there's a couple of details I've skipped over but I'll show it to you this afternoon, and pull it up into the hot cell facility itself.

At which point, the targets will be punctured and then we will cut them open, excuse me, and pour the material out for dissolution.

MEMBER REMPE: So, I have questions about loading still, too, as well as the seat. But, I know that there were some things mentioned and I don't know what's proprietary and not to ensure uniformity, but are you going to do any sort of checking of after the actual fill to make sure it's uniformly loaded and that the --

MR. REESE: Yes, so --

MEMBER REMPE: -- mass is the same as what you hope it's going to be? Is there a --

MR. REESE: One of the primary and probably the most important QA metrics, we are going to have monitor is that mass loading, absolutely.

MEMBER REMPE: Okay.

MR. REESE: So, there -- we anticipate a couple of steps to verify that.

MEMBER REMPE: Good, okay.

And then --

MR. REESE: And there's some nuances to what it looks like when it's in the target and I'll talk about that more this afternoon.

MEMBER REMPE: And then, again, I think I mentioned earlier, but how well are the universities characterizing their reactor and the amount of radiation that the targets will receive?

And, do you have some sort of QA to say, yes, it's been irradiated?

I mean, one, they could put some sort of instrumentation in their reactor extra for your device or you could also have something when you receive it. And, have you guys thought about that and what kind of QA you're going to put on that?

MR. REESE: Yes, I mean, one of the thoughts that we've put together is something as simple as an area radiation monitor because the amount of radiation coming off the targets should be substantially different between MURR and OSU enough that you can tell on an arm.

MEMBER REMPE: You could, but that's kind of gross thing. It seems like you could do something that's a little better fine-tuned so you don't wait until after you puncture it and say, well, hell, the things a lot hotter than I expected. I mean, that's what you're talking about.

Do you have a radiation monitor after you puncture it that you're going to detect that, right?

MR. REESE: No, no, just the gross radiation levels that are --

MEMBER REMPE: From the target --

MR. REESE: -- measured from the target itself. We don't need to puncture it or anything to tell the difference.

MEMBER REMPE: You think you'll be able to?

MR. REESE: Oh yes, very easily.

MEMBER REMPE: Okay. Okey-dokey.

MR. REESE: Okay, once we do that, we're going to dissolve it and we spoke to that a little bit already.

We will have an off gas and I believe it's talked about on there. Yes, yes, there's a slide forward on the off gas, how we handle the fission product gases, but we anticipate there's going to be fission product gases from the puncture itself and we have a system in place to handle that.

MEMBER POWERS: Basically a particulate?

MR. REESE: I'm sorry?

MEMBER POWERS: Do you anticipate particulate when you puncture?

MR. REESE: Not at this point, no. And, all of our research so far has shown it's -- yes, testing, sorry, has shown that hasn't even remotely been an issue.

There are some other things we can talk about this afternoon that this target material doesn't exhibit -- this target material doesn't seem to exhibit that are in our advantage, that are to our advantage, excuse me, along those lines.

MEMBER POWERS: There's usually, I mean, certainly when you puncture a fuel rod, you get particulates.

MR. REESE: Yes, and we'll talk about that this afternoon. There's a couple of unique things about it. It's kind of -- it's pretty neat.

CHAIRMAN CHU: I have a question.

MR. REESE: Yes?

CHAIRMAN CHU: How big is your dissolution tank?

MR. REESE: Do you know how many liters that is?

CHAIRMAN CHU: Small, right?

(Off microphone comments.)

MEMBER POWERS: Yes, it's long and thin, though.

MR. DUNFORD: Fifty liters.

CHAIRMAN CHU: And, that's one batch? Okay.

MR. REESE: That's the volume of the dissolution.

(Simultaneous speaking.)

CHAIRMAN CHU: Right, okay. And, that's considered one batch?

MR. REESE: That's correct.

MS. HAASS: Correct.

CHAIRMAN CHU: Thank you.

MEMBER SKILLMAN: Please talk about the venting. You puncture the target container. It's been irradiated.

MR. REESE: We know there is gases in there.

MEMBER SKILLMAN: So, you zip that thing open, you know you've got iodine, you know you've got krypton.

MS. HAASS: Right, xenon.

MEMBER SKILLMAN: Xenon. So, do you decant or you vent that to some place and you've got half-life you've got to deal with while that gas is sitting there and while you're deciding what to do with it.

Are the tank volumes and the relative pressures that this is basically manometer stuff, but you're moving gas, are those limitations on your batch size and on the backend of your process?

I'm thinking of what we had in big news was waste gas hold up tanks and waste gas decay tanks and we're talking big tanks. Are you talking big tanks? Small tanks?

MR. REESE: These are pretty small. So we essentially size it to hold much greater than the capacity over the time frame that the dissolution could take place and the volumes that we predict will come out.

We have also actually measured these off gases, so we have a pretty good idea of what's going to be coming off too as well.

MEMBER SKILLMAN: Okay, so the -- and your slide shows that these fission product gases are captured on the absorbers.

MR. REESE: Yes.

MEMBER SKILLMAN: How do you know your absorbers are healthy, that they haven't been degraded by the ingress of some other gas or some other compound or element that has killed the absorption capability?

MR. REESE: A very reasonable question. I'm not quite sure what's public and nonpublic, but so, in our fission product gas dissolve drop gas system, there's three trains.

Two trains are associated with the dissolvers and have some wet chemistry before you get to the fission product gas removal.

This particular unit has an iodine removal unit and there is then a -- well mobile gas absorber, a small -- it's the decay vent, it's not a tank capture, it's a decay vent and then after -- it's part that results of an iodine guard filter.

So, the process engineer on the area is -- I think we have to have a monitor on the guard filter and if that starts building up, that informs us that the primary iodine removal unit is having a problem or not working correctly.

So, that's the philosophy that we have right now on all three of those units is a secondary guard iodine filter effectively that we can monitor to see if that has a radiation build up.

Now, it sounds simple, unfortunately, you know, it's a very hot field because it's right next to some other stuff that has so there's some -- we'll have to work through what that looks like.

MEMBER POWERS: It's just calumniation, you'll get it. It's easy enough to do.

Now, you do have, especially in your xenon bed --

MR. DUNFORD: Yes.

MEMBER POWERS: -- build up cesium in there over the course of, what, the life time -- your life time's 30 years or something like that? How often do you change out that bed?

MR. DUNFORD: So, we have two design philosophies. We've got two locations where we have those carbon vents, a primary absorber and secondary absorber in the dissolver off gas system.

Our thought process is that the primary absorber will probably be replaced about every five years and the secondary absorber every two years nominally. It's a bigger absorber, a little bit more worried about it.

Having said that, though, at the last moly meeting in, actually, I shouldn't say moly meeting, but the meeting with Bariloche last year, the experience of INTEC and a couple others that have carbon is 20 years of experience they haven't had to change it out.

Obviously, that's predicated on how clean is your stream? Do you have any poisons in the stream?

MEMBER POWERS: Right, and how big your stream is.

MR. DUNFORD: Yes.

MEMBER POWERS: I mean, how big your bed is. I mean, if I were you, I'd go for the big -- for the life time because it -- I mean, carbon's cheap.

MR. DUNFORD: Yes.

MEMBER POWERS: Change outs are expensive. And, you're taking the moly in -- I mean the iodine in on a silver mordenite?

MR. DUNFORD: Yes, silver zeolite.

MEMBER POWERS: Yes.

MR. DUNFORD: Well, we have actually have both. We have -- in the system, we have primarily as the first unit is a silver zeolite, silver mordenite. And, the backups are typically carbon, though, either a carbon substitution, iodine substitution bed.

MEMBER POWERS: You're going to have to coat that because some of your iodine's going to get converted into methyl iodine?

MR. DUNFORD: Yes.

MS. HAASS: Yes, we're going to go, as I said, we're going to go through this in detail, so if you can hold off maybe on some of the detailed questions.

MEMBER POWERS: No.

MS. HAASS: No, no, no, we don't -- we want to answer your questions.

MEMBER POWERS: I don't trust this guy here.

MS. HAASS: I know.

MEMBER POWERS: This is one of the brothers.

(Laughter.)

MR. REESE: Yes, I think we actually met

some time in the '80s.

MEMBER POWERS: We have, many times. I mean, not many times, but we speak the same language or close enough. This is more fun. These guys talk about regulations, we can talk about process.

MR. REESE: So, the next step is to take that dissolver solution, get it through an iodine exchange column, pull out the moly. Moly is what pays the bills, so that's the first priority.

And then, those are sent to, I should say, they are sent to the lag storage. So it's going to sit there for --

MEMBER POWERS: And, you're pulling the moly out as moly-3? Triply charged moly?

MR. REESE: You're -- I can't remember the exact chemistry of that.

MEMBER POWERS: Well, you're in strong nitric acid?

MR. DUNFORD: Yes, it is. I'm out of the brotherhood, though, because I really couldn't verify that but I think you're correct.

MEMBER POWERS: Yes, I mean, I was sitting there trying to -- I mean, I've never pulled moly out on an ion exchange column. So, I don't know squat about it.

Acidic carbons are susceptible to silicic acid contamination?

MR. DUNFORD: So, these are actually the location where probably a single use and they're going to be millimeter size units.

MEMBER POWERS: Okay.

MR. REESE: But, there's too many questions to answer to the FDA --

MEMBER POWERS: Yes.

MR. REESE: -- if you don't switch them.

MEMBER POWERS: Yes. I agree with you on that because the silicic acid will screw up the column and antimony will screw up the column and things like that. But if you change it out ever time, then you don't care.

MR. DUNFORD: Yes, and the -- yes, it saves a lot of heartache with the FDA.

MEMBER POWERS: Yes, okay, okay, that makes sense. That makes a lot of sense, actually.

MR. REESE: So, we'll strip off the moly, part the solution, let it sit for a while and then we'll pull off -- we'll run the moly a couple more times to get it cleaned up for FDA quality assurance purposes.

And then, we're going to do some QA on that moly product, package the moly product and send it on its way.

On the uranium recovery side, so after all that's done, we go back, pull that flagged storage of the uranium solution and the first thing we'll do is we're run it through an exchange columns to pull out the uranium, excuse me, from predominantly the fission products to separate them out.

And then, we'll repeat that process again with a different set of columns to get the purity level on the uranium final product that we need.

MEMBER POWERS: What are your big contaminants?

MR. REESE: I'm sorry?

MEMBER POWERS: What are -- what else is coming off of the moly that you need to double up on it?

MR. REESE: There are some other metals.

MR. DUNFORD: It's really just two cycles just to get enough DF purification. The radioactive materials so we can go to a --

MEMBER POWERS: Yes, I just wondered what else it was coming off with, anything that's trivalent, I assume.

MR. DUNFORD: So the three things that obviously are of concern, that concern the NRC would be plutonium, where does the plutonium go in the system, which goes to the waste.

And, one of the reasons we see it, I'll also mention that we have delayed bed there is because we're waiting for antistilt to decay away because it's -- we're not sure we have enough data that says that it's decontamination package is going to be adequate, so we're just going to let it decay away for three weeks.

And so, otherwise, based on the data we have, the typical metals, the typical nonradioactive contaminants that therefore should come with -- should also just stay in the rapid stream or the waste stream going out.

MEMBER POWERS: You're not going to get any rare earth in this?

MR. DUNFORD: Let's take that to the staff if we could. I've got to read.

MEMBER POWERS: We get that.

MR. REESE: And then, the last thing is once that uranium's pure enough, we've got to let the 237 uranium decay away before we get can get contact handled uranium and pass it over to the Part 70 side.

On the waste management side of the house, we're going to have -- we'll spend a little bit of time on this this afternoon. We'll show you where these things actually sit.

We've got the storage tanks for the liquid. We split it into high and low dose streams.

So, the high dose streams get concentrated adjusted and basically we're going to use a commercially available solidification agent to solidify it up.

A lot of the recycled waters and stuff, we may end up solidifying that as well, but we're going to try to recycle as much of the water and material as possible.

But, a lot of that water material that we can't do anything with, we would consider these the low dose streams.

And the solid waste, we certainly anticipate generating solid waste. This would be standard handling of solid waste, dry solid waste packaging in 55-gallon drums.

And then, the -- there are some specialty wastes associated with some of the solvents that we will have to deal with, but those waste stream sizes are pretty, pretty small.

For the process off -- well, Gary's -- in the interest of time, they want to go through this pretty quickly because Gary essentially described this slide to us.

So, the idea is that we're going to capture the iodines and the kryptons and xenons, that's really what the process off gas system is set up to do.

We also recognize that your iodines will grow in as a result of decay as you go through this system. And so, we'll spend some time this afternoon talking about how we handle it. We recognize it and essentially we're going to capture it, funnel it right back to the same off gas capture system that we're talking -- a duplicate, I should say, off gas system that we have described here.

So, we recognize that we are going to have iodine ingrowth as a function of time and we have to capture that. So, those systems exist.

MEMBER SKILLMAN: Let me ask this --

MR. REESE: Or will exist, it's all on paper right now.

MEMBER SKILLMAN: Kind of pops in my mind due to operating experience I've had, you've got four zones of ventilation. The most negative of the four is zone one which is your hot cells.

And, two, three and four are intended to, cost, if you will, the congregation to move towards the center which is your hot cell.

In the middle of this, you've got these

tanks that are venting in a particular direction ultimately to these absorbers.

And, you also have atmospheric pressure coming over your plant.

Things change. And so, if your ventilation, which I'm beginning to think your ventilation and your cooling systems might be the two critical systems for this, your ventilation system is up and running, working fine. You're in the process of decanting or you're dissolving and you're moving off gas.

What happens, what consideration have you given to a failure or a trip in your ventilation system that kind of tilts the entire atmospheric balance to where now your gas isn't going to where it's supposed to go to?

Or, while you're in the process of whatever you're doing, you've got a storm system that comes over with a fairly low atmospheric pressure or a real atmospheric low and, you know, comes on you quite quickly like an approaching tornado or an approaching weather front.

Have you considered how, even though slight changes can cause this gas that you're talking about to end up where it's not supposed to be?

MR. REESE: Yes, correct.

So, we have, as a matter of fact, when we get to Chapter 13 eventually, we usually -- I mean, one of the sort of when you poke this system, when you have a complete loss of power right when you start the dissolution process is when you're probably arguably the most vulnerable.

MEMBER SKILLMAN: Your most vulnerable?

MR. REESE: Once you do -- once you start that, it's not going to stop. It just has to do its stuff.

And so, it's going to be evolving and you've got no power.

MEMBER SKILLMAN: Yes.

MR. REESE: So, we've addressed that situation.

On the more of the cycling of the barometric pressure as a function of time, what I can say is that the ventilation has to keep up with that. Right? The ventilation system has to be able to maintain the delta piece. If it can't, we've got a situation and, boom, we have to shut down the system.

But, the ventilation system, as I understand it, has been designed to handle those kinds of changes in barometric pressure to maintain negative pressure.

You know, when we get down to the IROFS, ventilation system's pretty important and that's one of our IROFS. So, we know that we have to maintain that negative pressure.

MEMBER SKILLMAN: Thank you.

MR. REESE: Yes.

MEMBER SKILLMAN: Okay, thanks.

MEMBER KIRCHNER: As we go forward, could you define, maybe it will come up this afternoon when you do a more in depth walkthrough of the building and all the zones, but where you're confinement barrier is --

MR. REESE: Yes.

MEMBER KIRCHNER: -- well confinement --

MR. REESE: I'll show you a picture of some of --

MEMBER KIRCHNER: Because it's not all four, right?

MR. REESE: That's correct. I'll show you the picture this afternoon.

MS. HAASS: Yes, we have some --

MEMBER KIRCHNER: Okay, please, yes.

MS. HAASS: We have some great cartoons for you to look at and we can show you.

MEMBER KIRCHNER: I'd like an elevation as well as --

MR. REESE: Yes.

MEMBER KIRCHNER: -- the floor plan. Thank you.

MR. REESE: Yes, we're going to show you at the mezzanine level, so on and so forth, yes.

So, we've got zones one through four. We've alluded to this.

Zone four is essentially independent of the others but we have free air supply into zone three and parts of zone two that needs fresh air. And zone one is cascaded from zones three and two.

MEMBER POWERS: Well, that's one of the issues that I've always puzzled about these nested design ventilation systems that you're leading the most likely area to get it in and fire it seems to me is out in zone four.

And so, all the particulate generated by that ends up in zone one, which is -- or maybe zone two, which is the area that you do not want to be contaminated with a lot of particulate. How do you avoid that?

MR. REESE: So, what you're -- let me feedback what you said.

Which, if you had a fire in zone four, how do you prevent particulate from making it into zone one?

MEMBER POWERS: Yes.

MR. REESE: Well, how do we describe this, Gary?

MR. DUNFORD: Thanks.

Well so, in our design, most of the zone four stuff is actually outside of the -- it's in the containment area so it's --

MEMBER POWERS: But be aware of more --

MR. DUNFORD: -- that's the --

(Simultaneous speaking.)

MEMBER POWERS: You have a fire in your --

MR. DUNFORD: Right, in zone three.

The smoke's going to get sucked back in through the, assuming the -- well, smoke should get sucked back in through the inlet zone two and three inlet system which is filtered. So, that would cut down that load or quickly shut off because I'm sure it would -- particulate would plug it after a very -- depending on how big the fire was after a not too long of a condition.

But, other than that, I don't -- I'm not going to say there's something designed. It's kind of the standard --

MEMBER POWERS: I know it's very standard and I've -- you don't have a way to evacuate this lower zones? I mean the ones --

MR. REESE: Evacuate the air?

MEMBER POWERS: Yes, without going --

The question I have is you bring in particulate, yes, and whatnot. But, you also bring in the hydrochloric acid from cables burning and things like that into these inner zones where you really don't want it.

And, I mean, I have the specific thing with there are a lot of digital electronics and things like that. I'll probably ask you a question about that and what it does, but you don't use a lot of digital in this system --

MR. REESE: No.

MEMBER POWERS: -- as far as I can tell.

MR. REESE: That's correct.

MEMBER POWERS: And, though I am interested in why you don't have a permissive system for -- where all these manual operations you have to do.

MR. REESE: A permissive?

MEMBER POWERS: Yes.

MR. REESE: Yes, I know what you're describing.

MEMBER POWERS: Yes.

MR. REESE: Yes.

MEMBER POWERS: I mean, I think those are a good idea.

MR. REESE: Yes, I agree. And, that hasn't been entirely fleshed out. As a matter of fact, we've punted that kind of thing to the operating permit. But, actually, we are kicking around how we would set up for a permanent system in our control room.

MEMBER POWERS: You don't have to -- I don't think it's a good idea to have the computer control things.

MR. REESE: No, yes.

MEMBER POWERS: But, I think having the operator type in, I'm going to go from A to B and have the computer say, you can't go to B because the valve's closed, is a good idea. So, it's just permissive.

MR. REESE: Sure.

MEMBER POWERS: It's not a controller.

MR. REESE: Right.

MEMBER POWERS: And, you might think about that because we tried to put on one of the MOX facilities and I think they cut down on the plumbing mistakes a lot. It's too easy to go from -- especially when you've got multiple tanks that they can go in to Tank B and you're actually trying to go into Tank C --

MR. REESE: Yes.

MEMBER POWERS: -- and things like that. And, it's -- just because of forgetfulness or everything looks kind of the same.

But, you're right, this question of you've got nested things, you are pulling bad stuff -- all the bad stuff from more zones ending up in the one area you don't want it.

MR. REESE: Other than the gross particulate filtration leaving from one zone to the other, there's really --

MEMBER POWERS: There's no --

MR. REESE: And, in the short time that the ventilation system will be running and smoke's in the -- sorry, the ventilation system, when we get into fire systems, we talk about detectors in the ventilation systems themselves to pick up on this.

MR. DUNFORD: Yes, but I think the other thing, though, I think we just need to consider that --

MEMBER POWERS: Yes, but you --

MR. DUNFORD: -- in a fire response to see if we want to shut off the zone two inlets.

MR. REESE: Right.

MEMBER POWERS: And, when we get to the fire, we may want to kick that one around a little bit. I don't have an answer for you, but it has been a curiosity to me. And everybody designs them this way.

MR. REESE: Yes, yes.

MEMBER POWERS: And, again, if you had a lot of digital systems in here that we -- I mean, I'd really agonize over it, but you're just not using a lot of digital in this design.

MR. REESE: No, there's not a lot of need for it either and it helps us with our cyber security plan, too.

MEMBER POWERS: Yes, yes, it does. And, we will probably chat a lot about fire suppression in the hot cells.

MEMBER SKILLMAN: I'd like to make another comment on your slide 57. You made this on a per application and it got some feedback that was one of the most valuable comments we made.

Ventilation systems are unique, at least from my perspective because people that work on them don't get wet and they don't get burned.

And so, think of the ventilation system in this room, it's hidden. You know it's -- you can hear it, but you don't know it's there unless you can hear.

MEMBER POWERS: Wait until this afternoon.

MEMBER SKILLMAN: If you design your facility so all of the ventilations tuck neatly as far in the overhead so that it's out of the way of all the other equipment, and you have a situation like what Dana's talking about where you have say sucking in from outside air, say the field across the road is on fire or you have a real hydrocarbon fire down on the main highway and you're pulling air in and you've poisoned all of your filters, vents, absorbers.

If you have done a good job of securing your ventilation to where you can't get to it, you almost have to build the inside of this -- you have to build the facility from the inside out to do a repair.

Whereas, if you bring that ventilation equipment down to where it's about shoulder height and you can get to it, even though it'll cost you some floor space, you have access to it in a way that you otherwise wouldn't.

MR. REESE: Well, correct me if I'm wrong, Gary, but most of that stuff sits on the mezzanine level.

MEMBER SKILLMAN: My point is, if you can get to it easily, you can save yourself exposures, time and resources.

MR. REESE: Absolutely.

MEMBER SKILLMAN: But, if you tuck it away nice and quiet like it's a bear to get to, you need scaffolding, you need to pull down the overheads, you need to --

MR. REESE: Oh no, we don't --

MEMBER SKILLMAN: -- do destructive kind of things.

MR. REESE: Ours will be a little more accessible than that.

MEMBER SKILLMAN: Thank you.

MR. REESE: So, the last slide is just a summary of all of the different reagents. Obviously, fresh LEUs coming to the system. There's the transfer of the targets to and from the reactors, chemical supply, you can recognize a lot of them have to do with the solid process.

MEMBER POWERS: But reductant is a fairly nebulous term.

MR. REESE: Yes, that's true. That's true. Do you know what that's referring to, Gary?

MR. DUNFORD: Oh yes.

MS. HAASS: Yes, we'll talk about that this afternoon.

MR. REESE: Oh, that's right, that's right, yes, yes. Never mind, yes.

MEMBER POWERS: Because that's the one that --

MR. REESE: That's one we have to save for this afternoon.

MEMBER POWERS: And, that's the one that usually gets these chemical storage facilities in trouble.

MR. REESE: Go ahead.

MS. HAASS: So, the last two slides are just some facility cross sections. You've seen them before. We're going to go over this in great nauseating detail this afternoon.

MR. REESE: Mic.

MS. HAASS: Oh, sorry.

Now, the next two slides are just the facility cross sections. And, as I said, we'll be going through this in great detail. And, I know that we want to move along a little bit.

CHAIRMAN CHU: Any questions?

MEMBER SKILLMAN: Well, yes. I had questions on the biological shield, other questions on ventilation. We never quite got that far in your presentation, will we hit that again later?

MS. HAASS: Yes, we will.

MEMBER SKILLMAN: Okay, okay, thank you.

MEMBER POWERS: Oh, one question. What I don't see in this facility description is what you do when you have to lay up this system for a long period of time.

That is, the hypothesis could be do we change these policies and won't send you fuel for a year because of whatever motivates the UE which is unknown to me.

Or, less likely, you've gotten a -- NRC's come in and done an inspection and taken your keys away and you have to prepare a discussion with the Commission.

These things happen and what I didn't see in the material I read is how do you lay this system up for six months?

MR. DUNFORD: So, I think in an ideal world, I'll use the word ideal to start with, it's straightforward, you take whatever is in the reactor that week, you don't put anything else in the reactor for the next week.

You dissolve it, you separate the moly,

you move the uranium and the waste to the uranium recovery system. You decay it for our time period. And, you separate and put it to the waste -- the waste goes to the waste system and then eventually the uranium goes to the long-term storage.

And, we have roughly 15 or 16 long-term storage tanks.

The target application's all batched so it's some of the -- a lot of the stuff is pretty easy to lay up.

The waste you would probably say, if they took the keys away completely, you just wouldn't put -- you wouldn't ship any waste. There are two large holding tanks and if you're not generating more waste, you don't have to -- you don't have to generate it, solidify the waste.

Now, so that's kind of the best of all worlds. In the intermediate perspective, I think you would say, okay, I'm going to bring that uranium or that target from the facility, it's just going to have to sit there and decay in their pool cells until it can -- until I get license back or my keys back.

And, I still think you would push through because I think that's the stable condition, you push through whatever was in the dissolver through the moly cycle and put it into the decay tanks and you could hold it there also.

The decay tanks are on our emergency purge system that there would be long-term safe storage, too. Not the ideal in my mind, but that would be another alternative.

I don't think you just want to stop and say, I've got have the dissolver done. You'd want to push that through the system.

MEMBER POWERS: Yes. And, this may get into more procedure and things like that, but you need to make sure that you can lay the system up, purge the lines and things like that.

And, it's a topic that didn't show up in the material that I've read as specific design capabilities.

MS. HAASS: It would be showing up in the operating license.

MEMBER POWERS: Well, the problem is, in my mind, it can't be ignored at the construction permit if it takes area. You have to have an extra tank or something like that because when they take they keys away from you, they're not going to let you do a lot.

They're not going to tell you to do zero because they're not going to leave you there.

But, things like a sleeping operator will get the keys taken away from you and whatnot.

But --

MR. REESE: I guess basically, if I could rephrase what Gary said is, we would probably finish the batch up and that leaves everything in a situation that's stable. It's not going anywhere. It's intended -- where it's intended to be is just to decay anyway.

MEMBER POWERS: You don't have a line purge and your tanks can tolerate just sitting there with a raw feed in them for a long time?

MR. REESE: That's correct.

MR. DUNFORD: We have some cooling systems and stuff that we'd want -- if you're going to be --

MEMBER POWERS: Yes, your heat load's not very high, though. I mean, heat's not your problem, corrosion's your problem.

MR. REESE: Yes.

MR. DUNFORD: Yes, one thing I'd probably add to that is we have a couple of columns that if it was a real long-term shutdown, we might decide to remove the spent resin or move the resin and spent resin.

MEMBER POWERS: Yes, okay, okay. But, give it some thought and see if there's anything --

special provision that you might need when you get to that because these facilities -- I mean, stuff happens.

(Laughter.)

MR. ADAMS: So, I'll start by saying this is an interesting chapter because there's a lot of information Northwest gives you and a lot of this is covered in other -- we look at in other chapters.

Chapter 4 is actually sort of we see as sort of an overview of the facility to us. That then spills out into other chapters and, you know, a lot of it was -- is on -- a lot of the discussion you heard was outside the Part 50 license, so it's not, you know, it's not even part of what we review as part of Chapter 4 or any of the other chapters.

MR. BALAZIK: This is Mike Balazik.

Dave Titinsky will be presenting Chapter 4.

MR. TIKTINSKY: Okay, so Chapter 4 Facility Descriptions, Al has pretty much talked -- just mentioned what it is, and I just want to make sure you've got the whole purpose of Chapter 4.

There's a lot of detail in 4, there's a lot of technical detail in 4 that the technical reviewers of all the various areas has utilized material in Chapter 4, plus there are other chapters in their reviews.

So, many of your questions I think you'll have will wind up -- we'll wind up answering them in the places where the review was actually done in the other chapters, not necessarily here but we'll obviously try and do the best we can to answer what we can at this level.

So, the facility description is addressed as the primary operations of the facility including a description of the process, the design descriptions, biological shields and processes involving specialty material.

And, some of the design description has design basis and other things like equipment and process control strategies, HAZMAT identification and IROFS. Again, all these things, a lot of design basis information is in Chapter 3 even though it's described here.

The IROFS are in the ISA summary, the methodology is in accident analysis in 13.

These are the hazards, so a lot of these things that are all -- they're spread out over various chapters in a different level of detail.

Next slide?

So, as Northwest has gone over, the

document in Chapter 4 talks about the target fabrication and scrap recovery. But, this was not reviewed as part of this application.

That'll be reviewed once we receive an application for Part 70 part of the facility.

So, the other portion of the facilities that are subject to review, the target receipt, disassembly, dissolution, moly recovery and uranium recovery is the focus of what we've looked at in Chapter 4.

You've seen this slide before, so I won't talk much about it, the issuance of construction permits and the use of NUREG-1537 and the ISG.

So, the various areas of review that were laid out in the SRP is, you know, the processes and containing, especially nuclear material, the design considerations, safety considerations are in the design, of course, the IROFS.

What is in the forms of the material, what's in there, where it is in the process, what types of byproduct material is generated in the solutions and the waste and the equipment and the properties of the equipment including moderating, reflecting where criticality control.

MEMBER SKILLMAN: Let me ask this

question, please, and it really gets to the heart of what was on your mind when I was reviewing Chapter 4.

Here are the questions, it was in Section 4.4.1.4 which is the summary of the process description.

I had these three questions, so let me fire the three questions and you might be able to answer them with one answer.

The first question was to what extent has this exact process with the masses in geometry been operated successfully before?

The second question is, to what extent are the criticality control features used elsewhere in exact or nearly exact dimensions in geometry?

And, question three is, to what extent are the masses virtually identical?

What I was really envisioning was, here is what was successful in this facility or just taken the pipes, the pumps, the valves, the pots and pans, everything exactly as it was and we're going to use it here in Columbia. That's kind of my vision of what might be a situation where you would say it's the same thing.

MR. ADAMS: We're not that lucky.

MEMBER SKILLMAN: You're not that lucky, okay.

MR. ADAMS: We're not that lucky. There's, you know, there's not a lot of examples to look at within NRC space. There was Cintichem and because that was an HEU based process, you know, they were under a 100 gram limit which made their process a lot more compact.

It's too bad there's not an operating moly facility in North America anymore because I think it's very -- would be very beneficial to take a look at one to see exactly, you know, what they looked like.

But, you know, unless you want to cross the ocean, that's the only way you're going to see it.

So, you know, the chemistry is similar to chemistries that have been looked at historically. But, you know, pump sizes and all that, that's sort of unique. And, you know, anything that exists out here that was HEU based, LEU based is different because there's just -- there's a lot more target you have to dissolve to get the same amount of, you know, same amount of --

MEMBER SKILLMAN: So, the takeaway then is, it's all custom, it is unique and so each feature needs to be analyzed uniquely.

MR. ADAMS: From a criticality point of view, yes. We don't get that deeply into, you know, is their chemistry good? Does, you know, that, you know, can they end up at the end of the day making moly-99? We don't really dig into that very deeply outside of the safety aspects of it.

MEMBER SKILLMAN: Okay, thank you.

MR. TIKTINSKY: I guess to add a little bit more to that, so even though there's not exactly analogs, in the fuel cycle world, I mean there is dissolution done. There is processes done. You know, the enrichments are different than our current fuel facilities and there's some information and you've probably seen it in the record, some questions related to, you know, the use of, you know 19.7 percent LEU compared to, you know, normal, you know, fuel fabrication.

So, even though it's not exactly the same, there is enough experience in things that are at least in the ballpark for the staff to do a good review on.

MR. ADAMS: So, there are examples, the Australians are using LEU and we've seen what they have at Anstel and we've had the opportunity to talk to the regulator.

So, you know, we do trade notes and try to understand and learn from other experiences.

MEMBER SKILLMAN: Thank you. Thanks.

MR. TIKTINSKY: So, there is a review of better in Chapter 4 the biological shield which has a lot to do with really the radiological review, doses and ventilation system, entry/exits.

Then you have the extraction system which, of course, it has the amount of materials, a lot of the criticality review as well as the radiation protection.

And then, the processing of SNM, which a lot of the chemical safety review, they receive the irradiated one, that's the Part 50 side, the unirradiated SNM is the target fabrication side which is the Part 70 piece.

Next slide?

So, sort of the summary of the application is that the safety considerations that factor into the design, a description of the processes, drawings and diagrams gives the staff a clear understanding or general understanding of what's in there.

The inventory and the forms of inventory of special nuclear material, criticality controls and then the various materials and waste things that are of the product.

So, really well of the materials that are within the facility.

The biological shield is, you know, the purpose of that is to reduce rad doses and accumulated doses in areas which are within the limits of Part 20.

The Northwest has discussed their ALARA program, a low as reasonably achievable for use of the facility.

They've talked about their shield materials, how they are designed to withstand seismic forces and other events maintaining their functioning as well as the function of the biological shields for the entry and exit of the product, the waste process equipment and staff.

So, again, this is the radiation doses for workers.

The extraction system --

MEMBER KIRCHNER: May I go -- I have to stop you there, David --

MR. TIKTINSKY: Sure.

MEMBER KIRCHNER: -- for a minute.

You used the word containment. How are you using that word here?

MR. TIKTINSKY: So, containment is the way we're using it the same way Northwest is using containment.

MEMBER KIRCHNER: Which is? I just worry

about terminology because I know this is not a power reactor, but words in NRR space that apply to power reactors and the family of Reg Guides and such have certain meanings that you probably don't want to confuse here or you'll confuse at great cost infers and complexity.

MR. TIKTINSKY: I've read through the terminologies tend to get us in trouble in the process and the fuel cycle --

MEMBER KIRCHNER: So, here, you mean containment as in containing the radioactive source terms?

MR. TIKTINSKY: Yes.

MR. ADAMS: But, maintaining control over.

MEMBER KIRCHNER: Control over?

MR. ADAMS: Yes, that, you know, there are some research reactors that do have containments, but as you'll see when we get to the in unit safety feature chapter, that specifically Northwest made a decision that a containment is not necessary for this design and confinement will work.

MR. TIKTINSKY: But, we're well aware of that the terminology, again, we mixed this up with the fuel cycle world, too. We try and not use the same terms as reactors because people think that's what we're talking about.

MEMBER KIRCHNER: Alex, since you said it, though, I didn't see it in the SER. You said that Northwest made a determination that containment wasn't necessary. What's the staff's position?

MR. ADAMS: This is coming attractions, this is Chapter 6 that I remember looking at the draft of 6. I believe we don't take exception to what Northwest is saying.

MEMBER KIRCHNER: Thank you.

MR. TIKTINSKY: So, the extraction system, a lot of the chemical processing of the received disassembly, dissolution, the purification part, description of the different parts of that so this feeds a lot into our chemical safety review of the facility.

Next slide?

So, again, as I have mentioned, a lot of these things cross over the various areas. I really do feed, you know, the criticality and chemical safety reviews by providing a lot of the information to back up and here, again, you'll see the details of those reviews that were done in Chapter 6 and Chapter 13, particularly all of the chemical and criticality reviews.

And, again, for the unirradiated part, the

Part 70 part has not been evaluated here.

So, in terms of what the staff looked at, we evaluated the technical information in the chapter to assess sufficiency of preliminary design, description of the processes, you know, again, the technical details are addressed in other chapters.

Next slide?

So, you know, we have the obviously the three areas here, biological shield, extraction system and processing of irradiated specialty material.

I'll just kind of give examples of what the staff is looking at. And, again, most of this is documented in other places.

So, reviews of the shielding at the facility and the designs such as entry and exit ports also included reviews of the source terms and the methods used for calculating dose rates.

For the extraction system and processing, the information supported the analysis of chemical hazards and the design of process equipment with respect to radiological and chemical releases to workers and the public and the prevention of criticalities of the facility.

And, I'd like to just note that the details of the technical review of those things are -- will be presented in the next few meetings that we have.

MEMBER KIRCHNER: Do you intend to do a detailed review of the confinement system?

MR. BALAZIK: Yes.

MEMBER KIRCHNER: Thank you.

MR. ADAMS: You'll see that at the next meeting.

MEMBER KIRCHNER: Just to include that as a bullet seems to me that's a very important part of the safety determination of adequate protection, the function of the confinement system.

MR. ADAMS: We agree. I think one thing to keep in mind is that from a hazard point of view, this facility is sort of like a small to medium sized research reactor as far as fission product inventories, isotopes available for release, that's sort of where it fits in on things.

And, not surprisingly, we're seeing the, you know, what we're seeing from the need for engineered safety features and that are also, you know, consistent with --

MEMBER KIRCHNER: I, for one, this is just an opinion, would not make that analogy or comparison. Basically, with a research reactor, say a trigger reactor, you've buttoned it up pretty well. You're not in thermal hydraulic space where it's a concern, criticality issues, of course.

But, you're not dealing with chemical processes and that's a much different world than operating a research reactor in terms of vulnerabilities and hazard analysis.

When you've got chemical process lines that have criticality issues, that have reactive chemicals, that have fire hazards that are far different than you would find in a research reactor.

So, yes, the source term may not be different, but the actual operation of the facility is much different.

MR. ADAMS: I agree. I was focusing on the source term.

MEMBER POWERS: On the other hand, research reactors have graduate students.

(Laughter.)

MR. TIKTINSKY: I'd say, you know, the facility really, a better analogue to actual facility is the fuel cycle facility. I mean we do --

MEMBER KIRCHNER: I'd be careful. The fuel cycle facilities you're talking about are making uranium fuel assemblies that are hands-on contact like the front end of this, the target path.

But, it's a different, and maybe I misspoke earlier, but, for me, this is like a recycling facility and that has a hazard complexity that's far different than making the targets in this facility or fuel for commercial reactors.

MR. TIKTINSKY: Yes, we do have fuel facilities that do chemical processes that are, I mean, again, not the same ones but they're certainly analogues, you know, similar types of things.

MEMBER BLEY: I agree. I --

MEMBER POWERS: They're fission products yet, so you do have criticality and chemical concerns, yes. But, when you're on the back end of the cycle and you're dealing with fission products, it's a different hazard vulnerability space.

MR. ADAMS: I agree and I didn't mean to make light of all those other issues outside of the source term.

MEMBER POWERS: I think the place we'll look at that is when we get to 13, right? The process system doesn't have all that much inventory, but the storage areas front and back do.

MR. TIKTINSKY: Yes, all these areas will be discussed in various chapters.

MEMBER KIRCHNER: Let me correct myself.

Earlier this morning I misspoke, I think. So, for the record, I don't mean by any means to compare this -- the hazards of this facility with dealing with large-scale handling of high level waste.

The point I wanted to make there was that, going through the step of developing process lines either scale or full scale to test out the processes is worth considering from both an economic standpoint as well as the safety concern.

MEMBER BALLINGER: These folks don't have any black cells.

MR. TIKTINSKY: Okay, so PSAR Chapter 4 provides a general understanding of the processes. The biological shield analysis offers reasonable assurance that the design will limit radiation exposures to 10 CFR 20 limits and ALARA.

Moly-99 extraction purification descriptions provide confidence in SNM byproduct fuels can be controlled and irradiated SNM can be processed and operated safely.

Again, these are the general types of conclusions that you find here. And, the details of why we would say these things are discussed in various chapters.

Next slide, Mike?

And, the last slide, which is one you've seen before here, the requirements in 50.35 to issue a construction permit for what's in Chapter 4.

MEMBER SKILLMAN: Let me ask this question on your safety evaluation. I'm on your page 4-6 and I'm at the second paragraph from the top of the page. Page 4-6 of your safety evaluation, second paragraph from the top of the page.

In that second paragraph is this sentence, this has to do with ventilation. The supplier will maintain the temperature for personnel comfort. Harmless sentence.

The question I have is, is the temperature of that air for personal comfort an important parameter for the success of the processes in the areas where people are?

For instance, one might say the correct temperature for personnel comfort is 72 degree Fahrenheit. But, if the area where that 72 degree Fahrenheit is supposed to be is now 104 Fahrenheit because the cooling system failed, do I now have tanks overflowing because the material that was in those tanks is a material that changes phase at 87.5 degrees Fahrenheit? And now, I have fizzing goo falling on the floor.

Is there a relationship between the temperature that is required for physical comfort and the temperature that is required for the processes combined?

MR. BALAZIK: I don't know the answer to that question sitting here. That's something we can look into.

This paragraph, like a lot of paragraphs in our SER is just is taking --

MEMBER SKILLMAN: It's an anticipatory --

MR. BALAZIK: Well, it's saying what the licensee's PSAR says. That's a statement that comes out of the PSAR. At this point, we're, you know, we're not coming to a conclusion on it.

MEMBER SKILLMAN: Well, you're saying it will provide, so you're making an assessment -- a forward thinking assessment of what the PSAR sentence is. So, you're, if you will, adding traction to the PSAR comment in your SER.

MR. BALAZIK: We'll have to go back and look and see how the PSAR is worded. That could be what the PSAR says.

But, I think you've pointed out an issue that we need to look at as we write this to make sure that when we're quoting the applicant that it's not misconstrued as being us coming to a conclusion or making a statement.

MEMBER SKILLMAN: Well, I'm thinking of that, but I'm thinking a few other things, too.

Sometimes we make the assertion that personal comfort will be provided by a certain temperature when that is a faulty logic.

I think, for instance, of the temperature in a control room where we say it should be, in most cases, below 104 degrees Fahrenheit and it has nothing to do with personal comfort, it has everything to do with digital equipment.

And, I'm thinking of shifts that I've been on where personal comfort was -- it's less than 120, it's a cool day down here. When in -- and we've been on shifts where the whole engine room, the whole engine room compartment is air conditioned and it is 72 degrees even with hot machinery.

So, my point is, is there a connection between personal comfort and process stability that is important in this context?

MR. BALAZIK: Yes, again, I don't think we know the answer to that question.

MEMBER SKILLMAN: Thank you.

MR. TIKTINSKY: Okay, that's it. Any

other questions?

(No audible response.)

CHAIRMAN CHU: If there are no questions, then we'll go to Chapter 5.

MS. HAASS: Well, I'm back.

So, the next is Chapter 5, Coolant Systems and Dr. Reese is -- he doesn't like to be called Dr. Reese, Steve will be going over the strategy and methodology and results that we have to date.

MR. REESE: So, predominantly, what this is looking at is decay heat from fission product and fission product inventories.

The -- we used chilled water in a couple of processes or in a couple of ways. One is not so important and one is important. So, we'll talk about those as we go through.

We do have a pretty good -- this is preliminary to this, we spent a lot of time on inventory, fission product inventory coming out of the targets of each reactor and also the heat load, decay heat load as a function of time coming out of the targets, too.

So, we have pretty good confidence on what those inventories look like as a function of time in each one of the systems, too.

So, we've looked at it as in a batch mode and also a steady state.

For chilled water use in the primary process vessels, we're looking at the large geometry standard loop and the criticality safe secondary loop and the hot cells and the target fab area.

There is selected gas treatment unit operations requiring cooling at less than the freezing point of water so that is the beds, so we're looking at the xenon beds there. That's the one we have to pay attention to.

But, I think we'll show -- I don't provide -- we don't, not that I, we don't provide the actual heat numbers in here. They are in the nonpublic SAR version. So, I don't really provide any decay heat powers nor do I provide any temperatures in this slide show.

MEMBER POWERS: I think xenon, it's okay, it's krypton that's going to be --

MR. REESE: Okay, yes, well, I apologize. We're worried about all of those, so xenon, mostly the xenons and the kryptons, correct.

MEMBER POWERS: Krypton is the one that's really difficult to -- I mean, you really have to cool things pretty good.

MR. REESE: Yes.

MEMBER POWERS: You have to keep that on the carbon.

MR. REESE: Yes, and that's the one that we have to pay attention to.

So, when we look at -- we know that the heat generation being produced from each of the targets. We know the decay heat times. We know what the -- what both of those source terms look like.

So, what they did was, they looked at the heat load in these process beds as a function of time.

They made a couple of -- and it's repeated a couple times in here, so I won't spend much time on it other than to say that, when they did this very simple heat load analysis, they basically looked at only in the radial and didn't account for any evaporation.

So, it's pretty conservative in that point of view. We didn't take the credit for just about anything else. So, that's what we mean by the vessels being unvented. We didn't take any credit for that in the analysis.

MEMBER SKILLMAN: Steve, before you proceed, back on your prior slide, you've got a large central process loop, then you have these three sub-loops.

Is the pump common to all three?

MR. DUNFORD: No. So, the external loop, the large loop that just goes out to process cool -- chillers, that provides cooling water to three heat exchangers that two of them are critically safe. So, they're very tiny and there are secondary loops then that are running inside of the large hot cells and in target fabrication.

And then, we have a couple locations, particularly the evaporators for the uranium cycle that are -- have to be -- you can't do it with a 6-inch diameter cooling coil, you have to have something bigger.

So, that is a larger diameter system and those are separate loops inside of -- so the large loop only goes to these three locations and the small loop goes to the 15 tanks and the dissolver.

And then, on the other one, it just goes to the target fabrication. So, they are -- the primary is a common loop but the individual three loops are all separate from each other.

MEMBER SKILLMAN: Is the circulating fluid brine? Is it ethylene glycol? Is it --

MR. DUNFORD: Right now, it's just --

MEMBER SKILLMAN: -- water?

MR. DUNFORD: -- going to be treated water.

MEMBER SKILLMAN: Treated water?

MR. DUNFORD: Treated water.

MEMBER SKILLMAN: Okay. The reason I ask is because there is other text that describes cooling for below freezing point.

MR. DUNFORD: Yes, that'll be the other bullet that Steve was talking about for the decay vats.

MEMBER SKILLMAN: Okay, and for that cooling system, like what is the coolant fluid?

MR. DUNFORD: I believe it's glycol.

MEMBER SKILLMAN: Ethylene glycol?

MR. DUNFORD: Yes.

MEMBER SKILLMAN: For that one in particular? Only for that one? Thank you, all right.

MR. REESE: So, when we looked at the analysis inputs, this was a case to address the comment earlier about we looked at the MURR targets because they will have substantially more inventory and substantially more decay heat as a result of the irradiation and because of the decay time this last.

So, it represents the source term that we need to evaluate in terms of heat.

So, we just used a very simplistic volumetric heat load looking through it. We took the tank sizes, specific heat, how much decay heat's there, looked only in the radial direction, didn't take credit for evaporation or venting and looked to see what kind of temperatures that we reached, was this going to be a problem that we were going to challenge, let's say, melting point of any of the materials we're going to use or, well, it's essentially that.

(Off microphone comments.)

MR. REESE: Yes.

MEMBER REMPE: So, there's no data yet from -- you've just done analyses, but I think the heat transfer coefficients were taken out of a handbook or something?

MR. REESE: That's correct.

MEMBER REMPE: Right? And so, how are you going to have confidence that you -- I mean, you had a lot of margin in the results, but how do you have confidence that you -- are you going to -- I heard earlier, you're going to have a small scale set up or something to have some data or something or --

MR. REESE: Well, the -- I guess the first place that we'll have confidence is when we do the first demonstration targets. We're going to take the temperatures on those and watch them as a function of time.

MEMBER REMPE: Is that permanently

installed instrumentation?

MR. REESE: No.

MEMBER REMPE: Is it just to know -- sampling to start off with?

MR. REESE: What we would do is, well, what I'm thinking is, honestly, is at OSU, we're going to drop it in and probably run it at 10 percent power for a couple days, pull it out, look at the isotopes and look at the decay heat just at that time to see if we're close before we do a full power run, those kinds of activities.

So, we can pull that -- we can pull it -- pull the target out and look at the inventory and the decay heat poppers as a function of time even before we're building this thing.

MEMBER REMPE: And --

MR. REESE: To know how close we are.

MEMBER REMPE: And then, when you get to the facility, are you going to have permanently installed instrumentation to give you confidence that the tank temperatures are indeed what you think --

MR. REESE: Yes.

MEMBER REMPE: -- and as you start up?

MR. REESE: Yes.

MEMBER REMPE: And things like that?

Okay.

MR. REESE: But, you'll -- in the nonpublic side, you'll see that those temperatures aren't very large.

MEMBER REMPE: Yes, and there's a lot of margin, yes, yes.

MR. REESE: Yes, yes, yes, yes.

Actually, the first sort of -- to get to what you're really interested in, we've got a couple of -- Carolyn alluded to the fact that we've done this multiple times in a couple of different reactors or in a MURR reactor and we're about ready to do it in another reactor on a much larger scale.

And, the inventories that we're predicting are very much in line with what we're seeing. And, all of the off gassing that we're seeing or that we predicted are very much in line with source measure.

So, we already have some confidence that we're able to calculate what the inventories are in the decay heats with follow through.

So, I'm not going to go through this in detail, but essentially, this describes places where we have cooling water jackets. And, these are various tanks as the process goes through, so a dissolution tank, the where the material goes just before or, I'm sorry, just after the moly gets stripped and the process material goes to another tank.

All of these tanks that we would like cooling water jackets on are listed there. We have some other decay tanks that we don't even think we will need them at all.

We calculated temperatures on them but those don't have cooling water jackets. We've also had some solid containers.

But --

MEMBER REMPE: I have one other question.

MR. REESE: Yes?

MEMBER REMPE: Some of your processes depend upon drying the tanks and that is reading some of the background material.

MR. REESE: Drying? Excuse me?

MEMBER REMPE: Yes, like you basically have to, when you're starting, this is in the -- I'd have to go back and look at the document about that, but you actually -- I'm thinking of spent fuel and how they have to dry it out basically before they start processing it that I read?

MR. DUNFORD: No, so we have two spots where you could use the word drying.

MEMBER REMPE: Okay.

MR. DUNFORD: One is when we made the target material itself when it first comes out of the bottom of the column after it's been washed a couple times. We dry it there --

MR. REESE: From the Part 70 side.

MR. DUNFORD: -- and reduce it.

MEMBER REMPE: Right.

MR. DUNFORD: And the other time we have -- we use the word drying is in before the carbon beds where we have some effectively low temperature glycol unit, it takes the water out of the air and reduces the air stream.

Those are the two places where we're drying. We don't have an issue like spent fuel might have like the K basins has where we had to go dry the fuel that had -- that came out of the cool cells because the cladding had been destroyed.

MEMBER REMPE: Okay. So, there's no concern if you aren't dry enough is where I was going with this.

MR. DUNFORD: Not at all.

MEMBER REMPE: Okay, thanks.

MEMBER KIRCHNER: Go back, I was just thinking through. So, your MURR targets will arrive a lot sooner, obviously, because of proximity than those from Oregon State.

What about the loading on the off gas system and the filters that you're cooling? Is that going to have an appreciable impact or is that the bounding design envelop that you use there?

MR. REESE: That's correct, the latter.

MEMBER KIRCHNER: Thank you.

MR. REESE: Where were we?

Okay, so the assumption was we have outside air of 95 degrees Fahrenheit. We assume the cooling water system is inactive and these are the assumptions. We're looking at maximum pressures and the maximum temperatures.

We also looked at overcooling the process system. And, this will get into the chemistry side which I'll defer to Gary if questions come up.

But, essentially, we're worried about precipitating at the solids.

Now, in this concern, I know that Mike and his folks have done a lot of work on the CRIT safety associated with this exact situation and we feel pretty confident that we're enveloped by the CRIT safety aspects including the pipe diameters and the tank diameters.

Questions on that?

So, on the gas management system, what we've done is we've looked at well, what happens if we lose that cooling system on those beds?

So, the beds warm up and release their inventory. And, what we're projecting is for the krypton and xenon, we're getting about a 150 millirem down wind of those. That's what we're really looking at.

So, you know, if you -- this is not the iodine beds, but this is the krypton and xenon beds. So, if this system fails, we're looking at an accident that results in about a 150 millirem.

And, if we didn't recognize it and didn't close the dampers and we didn't shutdown the ventilation system, all of those other things.

So, based upon that, it really didn't rise to the level of an IROF.

MEMBER SKILLMAN: Is that good or bad?

MEMBER POWERS: Yes, that's a good question.

MEMBER SKILLMAN: It seems to me that one would say, you know what? We're not even going to take the risk, we're just going to cool it.

MR. REESE: Well, we are. We are going to cool it.

MEMBER SKILLMAN: Cool it more.

MR. REESE: Well, this is -- we did the calculation based upon the thing not having any cooling. So, operationally, we intend to cool it and capture all of these things.

We looked at the, well, what would happen if we lost this cooling system? And, we only hit 150 millirem, so it doesn't really rise to the level of meeting an IROF. That doesn't necessarily mean that it is a -- using the terminology safety related non-IROF.

MEMBER SKILLMAN: I tell you what --

MR. REESE: We wouldn't want this to happen, right?

MEMBER SKILLMAN: We tell the public at TMI, you're only going to get 150 millirem, you'd get shot down.

MR. REESE: Understood, understood. But, it doesn't reach the level of an IROF. It does reach the level of a safety related non-IROF.

So, I mean, operationally, if we did this, we'd be in violation of a couple different Part 20 regulations and that's in that power loss.

MEMBER SKILLMAN: Okay. So, you're really going to 10 CFR 50, 10 CFR 20 Table 2 Column

1 or 2 saying we're not going to let that happen?

MR. REESE: Yes, well, yes, you're punching the 100 millirem per year ticket.

MEMBER SKILLMAN: Okay, thank you. I understand.

MEMBER POWERS: On your precipitation issue of cooling precipitation, what were you thinking could happen there?

MR. REESE: I'll defer to my colleagues.

MEMBER POWERS: I'm assuming this is an all nitric acid system.

MR. DUNFORD: It's actually just --

MEMBER POWERS: It's fairly dilute and I couldn't -- I was -- I'm trying to figure out, short of freezing it, how do I precipitate anything?

MR. DUNFORD: It's actually an ISF 1537 question that we had to address.

MEMBER POWERS: Okay.

MR. DUNFORD: So, we addressed it in a nonmechanistic way that -- and the criticality analysis that said even if this did happen, we don't --

MEMBER POWERS: Somebody put a trageling agent in by accident or something like that.

MR. DUNFORD: Oh yes, you could, yes.

MR. REESE: In summary, you know, none of the temperatures were challenging to the materials by a wide margin and none of the pressures we were talking about are going to be challenging to the materials by a pretty wide margin.

And the --

MEMBER POWERS: Did you get any foaming in your dissolver?

MR. REESE: I'm sorry?

MR. DUNFORD: He asked if we get any dissolver foaming, foaming in the dissolver.

MR. REESE: Oh. That's definitely a -- something you always worry about. We have not added any kind of, as part of a standard flushing kind of antifoaming agent or anything like that and don't have any plans to.

Disengaging section, downdraft condenser, so if it does happen, right now, I think in the normal MURR batch, you still have about 50 percent head space above the solution so that it can handle a small amount of foaming.

MEMBER POWERS: Okay, yes.

MR. REESE: We try to operate just below boiling, too, which is the other thing that --

MR. DUNFORD: We haven't seen it yet, either.

MS. HAASS: Right.

MEMBER POWERS: And any foaming agent is just going to get you in another set of troubles.

MR. REESE: Complications, yes.

MS. HAASS: Thank you.

CHAIRMAN CHU: No more questions, the staff come up?

MR. BALAZIK: Okay, this is Mike Balazik, Chapter 5 Cooling Systems.

Our technical reviewer was from ISL. Jim, are you on the line?

MEMBER BLEY: Jim, if you're on, give it another try.

MR. BALAZIK: Okay, Jim Servatius, are you on the line?

MR. SERVATIUS: Yes, can you hear me?

MR. BALAZIK: Yes, sir, I can hear you well.

So, like I said earlier, Jim will be presenting Chapter 5.

All right, go ahead, Jim.

MR. SERVATIUS: Okay, thank you.

As you heard in the presentations this morning, this proposed facility does not include a reactor so their cooling systems are not necessary to remove fission heat to provide shielding.

The principle purpose is to control the temperature of the process solutions during process and safely remove decay heat.

The system is designed and --

MEMBER BLEY: Excuse me.

MR. SERVATIUS: -- operated to maintain the vessel temperatures within the --

MEMBER BLEY: Excuse me.

MR. SERVATIUS: Yes?

MEMBER BLEY: Jim, you're cutting -- you're breaking up a lot. Are you on a speaker phone?

MR. SERVATIUS: Yes, let me take it off.

MEMBER BLEY: Okay, try it off.

MR. SERVATIUS: That better?

MEMBER BLEY: Well, don't know yet.

MR. SERVATIUS: The public line, I've been on all morning, the public line has been breaking up periodically, so I don't know that we can resolve it.

MEMBER BLEY: Sounds better now, keep going.

MR. SERVATIUS: Okay.

Bullet number three, the design of the cooling systems are based on interdependent parameters such as operating power of the reactor that irradiated the targets, the irradiation time, decay heat prior to the separation process beginning and the volumetric heat load and thermal flux at the heat transfer services.

In the proposed facility, as Northwest stated, a central process chilled water system acts as the facility cooling system and it cools the three secondary water loops in the hot cell and target fabrication areas through plated frame heat exchangers and transfers the heat to the environment through air cooled chillers.

MEMBER SKILLMAN: Jim, this is Dick Skillman. Let me ask this question, please.

MR. SERVATIUS: Yes, sir?

MEMBER SKILLMAN: Is there unique meaning intended with plate and frame heat exchangers versus some other type of heat exchanger?

MR. SERVATIUS: No, not necessarily. I was just describing it as Northwest had described.

MEMBER SKILLMAN: Okay, fair enough. Thank you.

MR. SERVATIUS: Yes.

As described before, the regulatory bases that applied include two requirements from 10 CFR Part 20 and three from Part 50. I won't go over those, they were already discussed.

The next slide discusses the acceptance criteria which has already been discussed, NUREG-1537 Part II and the Interim Staff Guidance.

1537 applies generally to all nonpower reactors while the ISG updates and expands the content to provide guidance in both preparing and evaluating an application for radioisotope production facility.

Slide 6, the areas of review, the staff performed a complete section by section evaluation of the technical information in Chapter 5, asked a few RAIs and got supporting information from those.

And, we assessed the sufficiency of the preliminary design in support of the issuance of a construction permit.

The evaluation focused on primarily the design criterion design bases and, in some cases, the relevant design information to provide reasonable assurance that the design will conform to the stated design basis.

And, by relevant design information in particular it was how the facility operates to ensure the design basis assumptions are met.

The six specific areas are in bullet number three.

One is the irradiated target design basis which is how much heat's being generated. The vessels that were selected for thermal characterization, whether the selections were representative enough.

Number three, the heat load and thermal flux calculations, the assumptions and methods and whether the calculations were conservative for the areas of review.

Fourth is the maximum vessel temperature and pressure estimates based on the heat load and thermal flux calculations.

And, the last two were the potential impact of overcooling and the potential impact on gas management system.

Slide 7, Chapter 5 as submitted by Northwest is not a complete description of the cooling system, but it contains a brief physical description with a comprehensive design basis for the system.

Chapter 5 references Chapter 9 for a complete description of the cooling system since the chilled water system is considered an auxiliary system.

The preliminary design is supported by several figures that show flow paths, components and estimated flow rates for the chilled water system.

The preliminary design is also supported by several tables that identify the heat load for selected vessels with and without water cooling and estimates of maximum temperature and pressure in those vessels.

And finally, the preliminary design is also supported by separate documents that describe detailed calculations of maximum vessel heat load, temperature pressure and a criticality evaluation in the event of overcooling of the process solution.

Since the facility has not -- does not contain a reactor and is at a separate site, it doesn't contain a reactor, therefore, it doesn't need primary or secondary cooling as would exist in a typical pool reactor.

The chilled water system is considered an auxiliary system and, at this time, is not an item relied on for safety nor is it required to be operable to protect the workers or public and the environment.

The final safety analysis, we'll have to confirm this position after Northwest completes the calculations for all vessels.

Slide 8, Section 5.1 of Chapter 5 contains the summary description of the cooling system and the design basis.

Specifically, Section 5.1.1 discussed the irradiated target thermal characteristics that depend on the source reactor and decay time prior to receipt of the target.

The proposed facility can receive targets from MURR and OSU and as yet a third university unnamed.

The targets irradiated at MURR generate the highest heat load, slightly less than what's on the slide there based on a minimum eight hour decay prior to receipt at the facility because it's located fairly close to the facility.

Targets from Oregon State take over 48 hours and generate less than one-tenth the heat load per target at the time of receipt.

Therefore, the MURR targets are used as the design basis for the cooling system and the eight hour minimum decay time becomes a significant factor in the design basis.

But Northwest states that, even though the MURR reactor is in close proximity to the production facility, target handling and transport times are projected to require significantly longer than eight hours.

As an additional measure, the clock time is recorded on transfer papers and the target will not be unloaded before eight hours has elapsed after the end of irradiation.

MEMBER SKILLMAN: This is Dick Skillman.

On that same slide --

MR. SERVATIUS: Yes?

MEMBER SKILLMAN: For the decay heat loads or for the product concentrations, what is the uncertainty or rather what is the certainty? How certain are you and how certain are the NWMI personnel of the accuracy of those projected heat loads?

MR. SERVATIUS: I think Northwest should answer that. It's just a fairly straightforward calculation from what I saw in the document.

Would someone from Northwest like to answer that?

MEMBER SKILLMAN: Would someone from NWMI like to answer that question? What is the certainty of your calculations for the decay heat generation rate or the heat loads that will be handled for these two reactors?

MR. REESE: Sure. This is Steve Reese.

So, what is the certainty? When we did the calculation, the calculation's largely based upon MCNP original neutronics of the targets themselves.

And then, based upon that, it's the MCNP information is transferred to ORIGEN where decay hat is calculated and then decayed out as a function of time.

We spent quite a bit of time both at OSU and at MURR validating those input decks to make sure that they're actually predicting what they say they're predicting. They're predicting them correctly.

The code that was used at OSU was based upon, so that we could maintain the same methodology, the same code that used during our license renewal.

So, we -- and we have a lot of data showing that that code is accurately predicting the powers and reactivities of the -- within our core.

The isotopics, MCNP usually how it's done is once you run MCNP then it's transferred to ORIGEN and decayed out with ORIGEN. And, that's largely what we did.

What we -- either that or -- that's what we did at OSU.

What we did at MURR is we ran it with Monty which is not dissimilar from that concept.

So, we're using two valid -- two codes that are validated for our reactor systems from previous operating history.

The isotopics that we see, in other words, basically, moly is pretty good vision yield, so it's usually used as a marker. So, the moly that we're predicting is pretty close to what we actually see so that gives us confidence there.

And, I can only talk about it in the smaller scale experiments that we've done at MURR so far.

And, finally, the isotopics that come off of the target material that predicted, based upon that MCNP input deck and the ORIGEN decay have done a really good job of predicting actually what was measured in then off gas above the targets.

So, we've got a pretty good feel for it.

As far as the decay heat itself, we haven't physically measured that yet, but if it's -- it should be in line with our isotopics and that's done a reasonable job.

MEMBER SKILLMAN: Okay, thank you. Good explanation, thank you.

MR. REESE: We also, it was reminded to me, we also add a safety margin on top of that to the calculations.

MEMBER SKILLMAN: Thank you.

MR. BALAZIK: All right, Jim, continue on with your presentation.

MR. SERVATIUS: Okay, slide 9.

As summarized in this first bullet, a

review of Chapter 5 found an inconsistency between the number of MURR targets assumed in the cooling system design basis which is eight targets per week and the facility design basis that can process 12 targets per week.

So, Northwest resolved this inconsistency by agreeing to change the design basis to 12 MURR targets per week for the cooling system and promised to update supporting calculations.

The design basis and overall conclusions aren't expected to change based on the larger volume contained in the processed material because the design basis uses a very simple 1-D radial heat transfer model based on uranium concentration, vessel characteristics and bounding in the air temperature.

And those are all independent of the actual volume of material in the vessel.

Next slide?

This slide discusses the next two design basis items. Section 5.1.2 discusses rationale for selecting the representative vessels for calculating vessel temperatures and pressures.

And, Section 5.1.3 discusses the heat load and thermal flux for those vessels selected.

As stated in the first bullet there, the vessel selected fell into three groups.

Group one where vessels containing liquid solutions equipped with water jackets.

The second group were vessels containing liquid solutions without water jackets.

And, three were -- third group was solid transfer containers with no cooling jackets.

The thermal characterization of every vessel in the facility was not assessed.

The staff determined that these three groups and the vessels selected within these three groups adequately bound the range of potential heat transfer rates and types of containers and demonstrates an adequate design basis for the cooling system.

The staff also considers the design basis sufficient for satisfying the standards for issuing a construction permit.

The second bullet describes the design basis for calculating the heat load and thermal flux.

Conservatism is included in the calculation of thermal flux by assuming simple steady state 1-D radial heat transfer and it neglects axial heat transfer and neglects heat losses through evaporation.

The staff agrees that this design basis

is sufficient for satisfying the standards for issuing a construction permit.

One note on this point is that the simple radial heat transfer design basis is not considered applicable for the dissolver.

So, estimates of heat load and thermal flux for that vessel are still pending. And, the evaluation of these calculations will be performed as part of the final safety analysis report.

Slide 11, the next design basis item is the calculated maximum vessel temperatures and pressures.

The design basis assumes the chilled water system is not operable. The vessels are not vented and ambient temperature is 95 degrees.

The calculated pressures are based on simply the vapor pressure of water at the estimated temperature even though the total vapor pressure of the solution would be lower considering nitric acid or uranyl nitrate into liquid states.

So, this design basis is conservative, therefore, the staff determined that it is adequate for supporting the preliminary design and is sufficient for issuing a construction permit.

Slide 12, Section 5.1.5 deals with

overcooling of the process solutions. It has the potential to precipitate solid uranium, increasing the uranium concentration in the process vessel.

As state here, Northwest evaluated this impact of precipitation on nuclear criticality by interspersing a conservatively high uranium solution among vessels containing a conservative nominal process concentration of uranium and then calculate the potential criticality.

This design basis is considered adequate and a thorough review of the criticality analysis will be performed as part of the final safety analysis report.

The staff determined that the design basis including the uranium concentration used to represent the precipitation and the assumed concentration of uranium in the process vessels is conservative, therefore, we determined that this design basis is adequate for supporting the design in the chilled water system and is sufficient for satisfying the standards for issuance of a construction permit.

Slide 13, the final design basis item is the impact on the gas management system which provides delayed time -- decay time for notable gases, krypton and xenon.

Northwest evaluated the impact on the staff's management system by considering the consequences of a bounding release of krypton and xenon isotopes and comparing that dose rate with the performance requirement defined in 10 CFR 70.61.

The staff considers this design basis including the level of detail and those dose rate calculations is adequate for supporting the preliminary design and is sufficient for issuing a construction permit.

Slide 14, these final three slides summarize the finding and conclusions of the cooling system evaluation.

The ISG augmenting NUREG-1537 Part II states that the Chapter 5 of the safety analysis report should contain sufficient information to support the conclusion that the applicant has described and analyzed the chilled water system such that it removes sufficient heat to ensure the integrity of components.

After reviewing and evaluating Chapter 5, the staff finds this level of detail provided on the facility cooling systems is suitable to determine four specific findings discussed on this slide and the next slide.

So, first the facility is designed to

operate with minimal heat load during normal operation and it does not require the chilled water system to be operable to limit the maximum temperatures and pressures to safe values.

Second, since the facility is independent of the irradiation facility, there are no long lived fission product build ups in the irradiated targets.

Thirdly, on the next slide, a maximum temperature and pressure that are estimated for the facility vessels are not high enough to cause a failure of process apparatus even if the chilled water system isn't operable.

So, therefore, the cooling systems are not items relied on for safety and, while this statement must be substantiated, again, with further calculations of especially the dissolver vessel, we find that the design of the cooling system as they have documented it in the preliminary safety analysis report is sufficient for satisfying the standards for issuing a construction permit.

And, fourth and finally, after reviewing Chapter 5 and the overall design bases, the staff finds that, based on engineering judgment, the level of detail describing the cooling system is adequate for issuing a construction permit because of the low heat load and the fact that it opposes little to no risk to the public.

So, the last slide discusses the staff's conclusions with respect to Chapter 5 and Northwest has met the following requirements of 10 CFR 50.35 for issuing a construction permit with respect to the cooling system.

First, cooling systems have been described by summary in Chapter 5 and a detailed description in Chapter 9. But, Chapter 5 does contain the principle architectural and engineering criteria for the design with a detailed design basis.

So, further technical or design information, for example, as I just described, the dissolver maximum vessel temperature and pressure at the start of the dissolution cycle may be reasonably left for later consideration in the final SAR.

Third, since the maximum temperature and pressure assume the cooling system is not operable and temperatures and pressures are low enough to ensure process vessels will not fail, the cooling system is not an item relied on for safety.

And the major features don't need to be functional for the protection of the health and safety of the public.

And, lastly, based on the preliminary

design and estimates of maximum temperature and pressure, there is reasonable assurance that the facility can be constructed and operated without undue risk to the health and safety of the public.

Any questions?

I think your previous question on the details of the calculation were contained in a standalone separate report that was not reviewed, so I apologize I didn't know the answer as to the conservativism of the decay heat generation rate.

MEMBER REMPE: Jim --

MEMBER SKILLMAN: Thank you.

MEMBER REMPE: -- are you saying that you did not review the underlying reports?

MR. SERVATIUS: I didn't -- I did not review that technical report, no. I reviewed primarily the design bases and not the detailed calculations.

MEMBER REMPE: Thank you.

CHAIRMAN CHU: Any other questions for Chapter 5?

MEMBER KIRCHNER: Jim, this is Walt Kirchner.

Since you identified some, let me say, issues with the dissolver analysis, what are the implications? That's certainly a very important component in the process line.

MR. SERVATIUS: I expect what they will find is when they go to a slightly less conservative design basis, other than that simple steady state radial heat transfer, I think they're going to find the temperatures and pressures would be acceptable even without cooling.

But, the fact that they did not finish that calculation or include that in their evaluation, brings into question whether or not they can still categorize the cooling system as not an item relied on for safety.

That's my take.

MEMBER KIRCHNER: Well, my estimation would be this is not a very difficult calculation to perform to resolve the issue.

MR. SERVATIUS: Yes, I agree.

MEMBER KIRCHNER: Thank you.

MR. SERVATIUS: I would hope they would provide that in an update to the preliminary report.

CHAIRMAN CHU: If there are no more questions for Chapter 5, I would like to now give the public comment an opportunity to give comments if there are any.

Are there any in the audience?

(No audible response.)

CHAIRMAN CHU: No?

(No audible response.)

CHAIRMAN CHU: Are there public on the phone line who would like to make comments?

(No audible response.)

CHAIRMAN CHU: No? Okay.

So, what we're going to do now is take 15 minutes break and, after that, we are going to hold a closed session for Chapter 4.

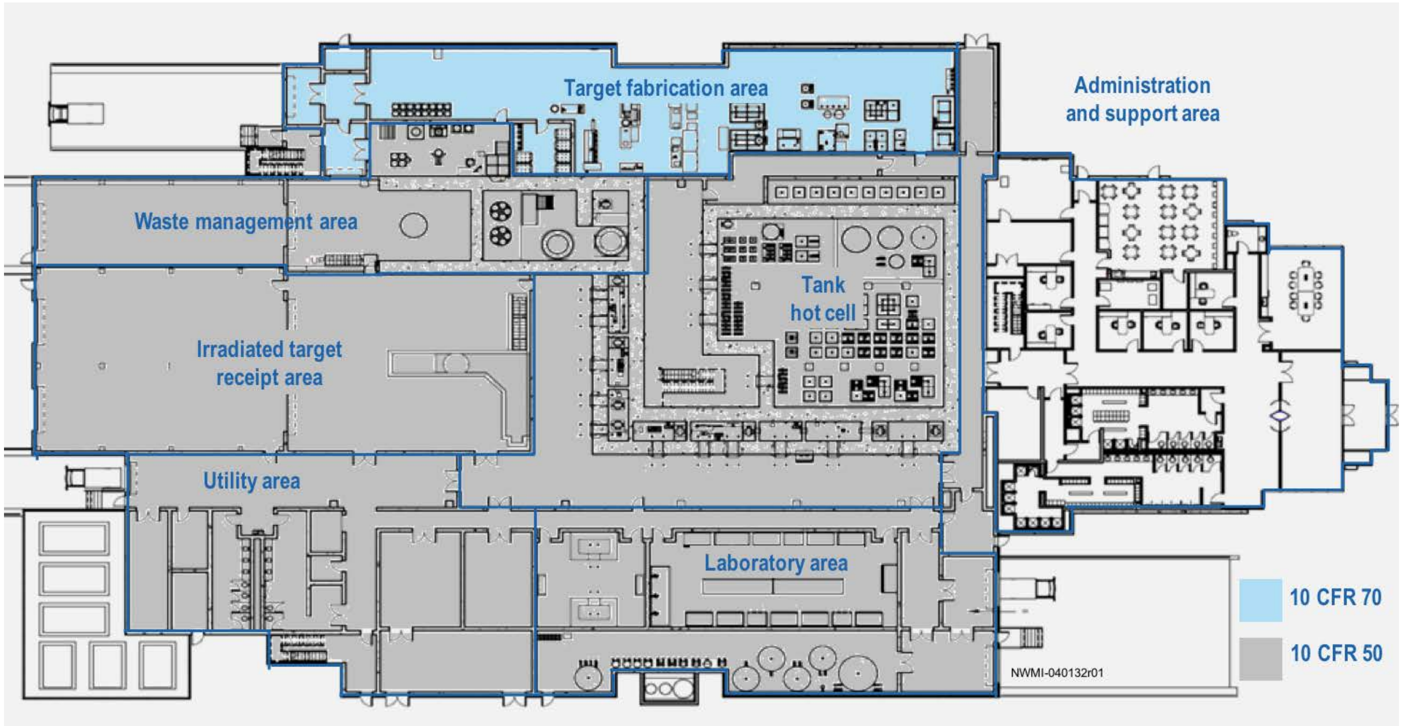
(Whereupon, the above-entitled matter went off the record at 3:04 p.m.)

U.S. Nuclear Regulatory Commission
ACRS Subcommittee Review

Public Session – Chapters 1, 2, 4, and 5

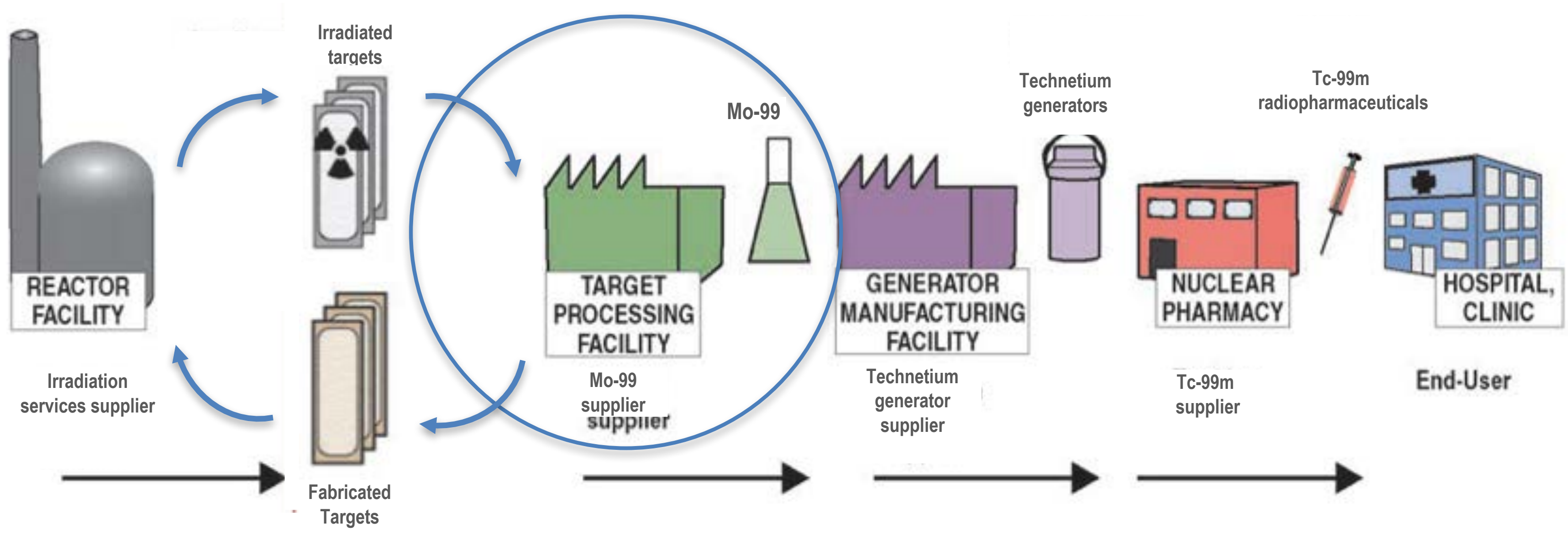
June 19, 2017

U.S. Nuclear Regulatory Commission
ACRS Subcommittee Review



Chapter 1 – Summary
June 19, 2017

NWMI Business Model



- Captive Network of University Research Reactors
  - Reliability/assurance of supply
  - Multiple shipments/week
- Radioisotope Production Facility (RPF)
  - Fabrication of LEU targets
  - Mo-99 production
  - Uranium recycle and recovery
- Domestic Mo-99 Generator Distributors
  - Hold FDA Drug Master File
  - No changes to generators
  - No changes to supply chain

OSU Oregon State UNIVERSITY

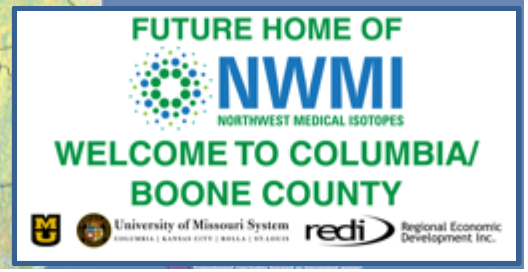
MISSOURI

Lantheus Medical Imaging

CURIUM™ LIFE FORWARD

GE Healthcare

University Reactor Network and RPF Location



Third reactor selection complete; not yet socialized

Facility Siting – Discovery Ridge Research Park

- University system-owned 550-acre research park
- NWMI "anchor" for radioisotope ecosystem; two existing companies
- RPF would be located in Lot 15 of Discover Ridge Phase II section (54.9 acres)
- Lot 15 is 7.4 acres and contains no existing structures

Source: MU, 2011, "Phasing Overview," Maps and Roads, Research Parks & Incubators, Discovery Ridge, www.umsystem.edu/umrpi/discoveryridge/maps, University of Missouri, Columbia, Missouri, accessed July 2013.

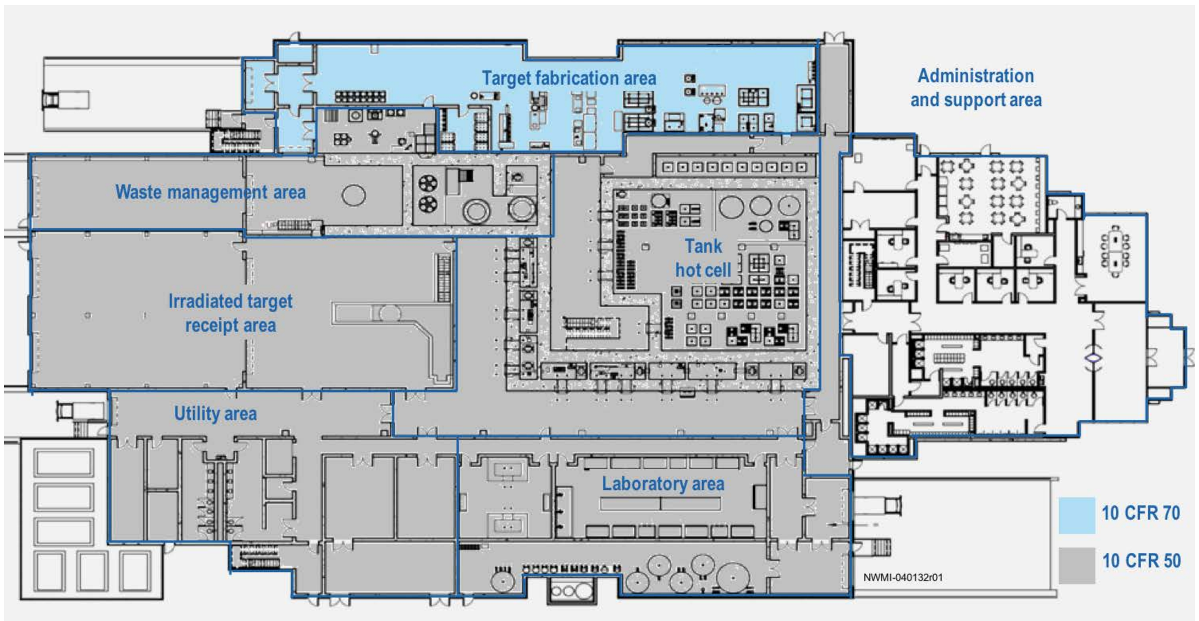
Facility Site Layout – Lot 15

Licensing Approach

- ***License Request:*** NWMI has submitted a Construction Permit Application to obtain a license for a production facility under Title 10, *Code of Federal Regulations* (CFR) Part 50 (10 CFR 50), "Domestic Licensing of Production and Utilization Facilities"
  - Using guidance in NUREG-1537, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors – Format and Content*
- ***Proposed Action:*** Issuance of an NRC license under 10 CFR 50 that would authorize NWMI to construct and operate a ^{99}Mo RPF at a site located in Columbia, Missouri
- RPF will:
  - Receive irradiated LEU targets (from a network of university research or test reactors)
  - Process irradiated LEU targets for dissolution, recovery, and purification of ^{99}Mo
  - Recover and recycle LEU to minimize radioactive, mixed, and hazardous waste generation
  - Treat/package wastes generated by RPF process steps to enable transport to a disposal site
  - Provide areas for associated laboratory and other support activities

Additional RPF Licensing Activities

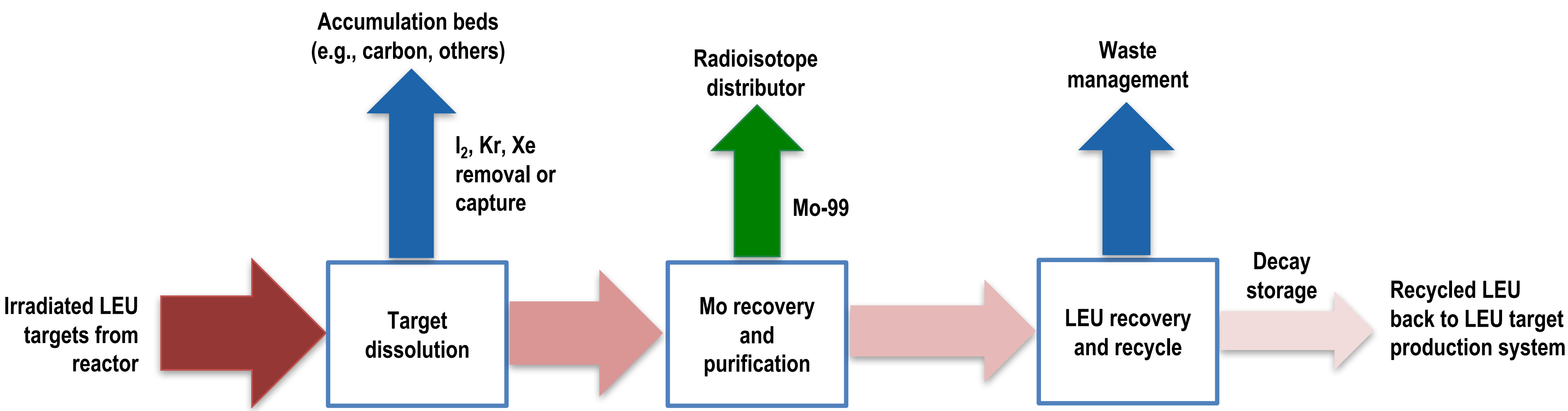
- Additional RPF operational activities are subject to other NRC regulations
  - 10 CFR 70, “Domestic Licensing of Special Nuclear Material,” to receive, possess, use, and transfer SNM
    - Receiving LEU from DOE
    - Producing LEU target materials and fabrication of targets
  - 10 CFR 30, “Rules of General Applicability to Domestic Licensing of Byproduct Material,” to process and transport Mo-99 for medical applications
    - Handling of byproduct material
- University reactor(s) and cask licensee(s) will amend their current operating licenses



NWMI NORTHWEST MEDICAL ISOTOPES

Primary Assumptions

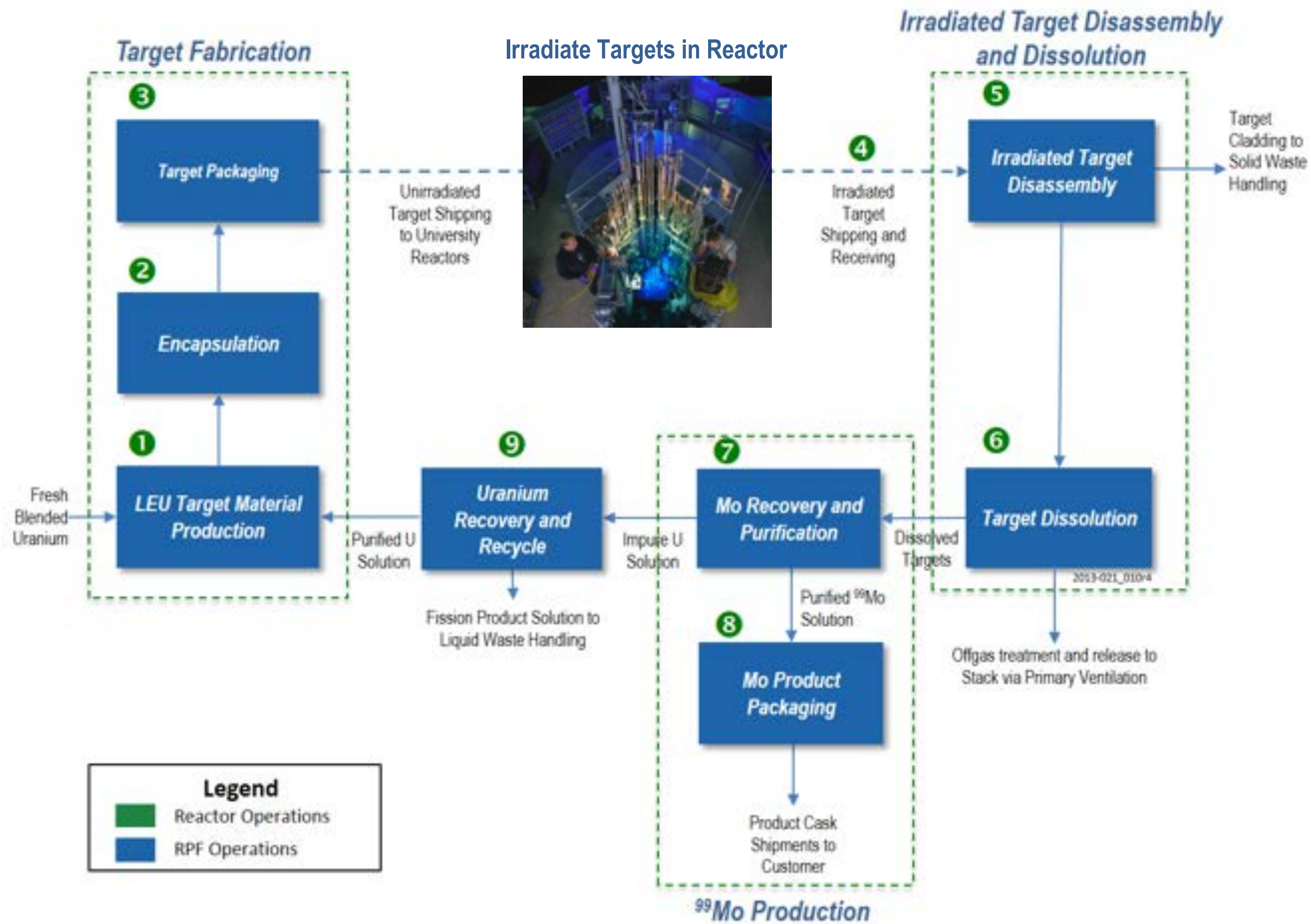
- Single radioisotope production facility → RPF
  - RPF includes target fabrication, Mo-99 production, and uranium recycle and recovery
  - Mo-99 produced using a fission-based method – "Gold Standard" using LEU
  - Nominal capacity 3,500 6-day Ci; surge capacity of 1,500 6-day Ci
- Use network of university reactors
  - Use same target design for all reactors
  - Intellectual Property obtained
    - U.S., Australia, Russia, South Africa, Korea → Allowed
    - India, Europe, China → Pending
- Fission product releases will comply with environmental release criteria
- Generate Class A, B, and C wastes; no greater than Class C (GTCC) waste



Proposed Schedule (Calendar Year)

- Start date of site preparation/construction → Q1 2018
- End date of construction → Q2 2019
- Start date of facility startup and cold commissioning (pre-operational) → Q3 2019
- Date of hot commissioning and commercial operations → Q4 2019/Q1 2020
- Date of decommissioning: 2050

Operating Characteristics



❶ LEU target material is fabricated (both fresh LEU and recycled U)

❷ LEU target material encapsulated using metal cladding → LEU target

❸ LEU targets are packaged and shipped to university reactors for irradiation

❹ After irradiation, targets are shipped back to RPF

❺ Irradiated LEU targets disassembled

❻ Irradiated LEU targets dissolved into a solution for processing

❼ Dissolved LEU solution is processed to recover and purify ^{99}Mo

❽ Purified ^{99}Mo is packaged/shipped to a radiopharmaceutical distributor

❾ LEU solution is treated to recover U and is recycled back to Step 1

Operating Characteristics (con't)

- Ventilation System
  - Ventilation system will be divided into four zones (Zone I, Zone II, Zone III, and Zone IV) with airflow directed from lowest to highest potential for contamination
  - Zone I ventilation system will be initial confinement barrier and will include gloveboxes, vessels, tanks, piping, hot cells, and Zone I exhaust subsystem
- Biological Shield
  - Biological shield will provide an integrated system of features that protects workers from high-dose radiation generated during facility operations
  - Primary function of biological shield will be to reduce radiation dose rates and accumulated doses in occupied areas to not exceed limits of 10 CFR 20/RPF ALARA guidelines program
  - Shielding and its components will withstand seismic and other concurrent loads, while maintaining containment and shielding during a design basis event
- Engineered Safety Features (ESF)
  - ESFs are active or passive features designed to mitigate consequences of accidents and to keep radiological exposures to workers, public, and environment within acceptable values
  - Confinement is considered a general ESF that is credited as being in place as part of PHA

Consequences from Operation and Use of Facility

- Primary consequences resulting from operation of RPF operations are radiological
  - Produce LEU target material that will then be irradiated in a network of university reactors
  - After LEU target material is irradiated, material will transported back to RPF and processed to extract and purify Mo-99
  - Radioactive waste materials will be processed and/or converted to solid wastes for shipment to off-site disposal facilities
- RPF Anticipated radionuclide inventory is based on a weekly throughput of targets (processed at 8-hour EOI) at Network of University Reactors
  - MURR → 8 targets
  - OSTR → 30 targets
- Maximum radionuclide inventory is based on accumulation in various systems dependent on process material decay times
- Calculated radionuclide inventory (Ci) for different process streams in RPF

System	Ci	Time (hr EOI)
Target dissolution	277,000	8
Mo feed tanks	205,000	8
U system	200,000	16–504
Mo system	11,000	32
Mo waste tank	5,000	32
Offgas system	127,000	
High-dose waste tanks	187,000	8–504
Uranium recycle	1,000	504–2,688

Integrated Safety Analysis Methodology

- RPF was evaluated using an integrated safety analysis (ISA) process
  - Preliminary hazards analysis (PHA)
  - Follow-on development and completion of quantitative risk assessments (QRA) to address events and hazards identified in PHA as requiring further evaluation
- Accident sequences were evaluated qualitatively to identify likelihood and severity using event frequencies and consequence categories consistent with regulatory guidelines
- Each event with an adverse consequence (involving licensed material or its byproducts) was evaluated for risk using a risk matrix that enables user(s) to identify unacceptable intermediate- and high-consequence risks
  - Items relied on for safety (IROFS) were developed to prevent or mitigate consequences of events
  - Risks were reduced to acceptable frequencies through preventive or mitigative IROFS
- Event trees analysis was used (certain circumstances)
  - Provided quantitative failure analysis data (failure frequencies)
  - Quantitatively analyzed an event from its basic initiators to demonstrate that quantitative failure frequencies are highly unlikely under normal standard industrial conditions (i.e., no IROFS required)
- Management measures were identified to ensure that IROFS failure frequency used in analysis was preserved and IROFS are able to perform intended function when needed
- Translation of IROFS (10 CFR Part 70) to technical specifications (10 CFR Part 50) will be developed

IROFS Boundary Definition and Technical Specification Development

- Continue ISA process development → Baseline documents used to develop final safety analysis report (PSAR/FSAR), operating license application, and technical specifications
- ISA baseline documents include:
  - Process descriptions
  - Process Flow Diagrams (PFD) and Process & Instrumentation Diagrams (P&ID)
  - Supporting calculations (e.g., release consequences, dose consequences, shielding calculations, etc.)
  - Hazard Analysis
  - Criticality safety evaluations (CSE)
  - Fire hazards analysis (FHA)
  - Qualitative Risk Assessments (QRA)
- IROFS boundary definition package will be developed to incorporate relevant information from all of these documents into one place for each IROFS
  - Living documents that will be updated throughout construction phase and operating life of RPF as changes to implementation of IROFS and their management measures evolve
  - Technical specifications are developed from IROFS boundary definition packages

Safety Related Definition

- Safety-related is a classification applied to items relied on to remain functional during or following a postulated design basis event (DBE) to ensure:
  - Integrity of facility infrastructure
  - Capability to shut down RPF and maintain it in a safe shutdown condition
  - Capability to prevent or mitigate consequences of postulated accidents identified through accident analyses that could result in potential offsite and worker exposures comparable to applicable guideline exposures set forth in 10 CFR 70.61(b), 10 CFR 70.61(c), and 10 CFR 70.61 (d) "Performance Requirements"
  - Operation of RPF without undue risk to health and safety of workers, public, and environment to meet 10 CFR 20 normal release or exposure limits for radiation doses and applicable limits for chemical exposures
- Safety-related IROFS - SSCs identified through accident analyses as required to meet performance requirements of 10 CFR 70.61(b), (c), and (d) (Table 3-2)
- Safety-related Non-IROFS -SSCs that provide reasonable assurance that RPF can be operated without undue risk to health and safety of workers, public, and environment, and includes SSCs to meet 10 CFR 20 normal release or exposure limits
- Non-safety-related - SSCs related to production and delivery of products or services that are not in above safety classifications

Preliminary Hazard Analysis

- Completed PHA on eight “systems”; 107 nodes were evaluated (PHA tables ~300 pages)
- ~140 accident sequences were identified for additional evaluation; 75 accident sequences were evaluated in QRAs
- 8 QRAs were completed, covering 75 accidents; 1 QRA addressed chemical accidents

Qualitative Risk Assessment Documents
Radioisotope Production Facility Preliminary Hazards Analysis
Radioisotope Production Facility Integrated Safety Analysis Summary
Chemical Safety Process Upsets
Process Upsets Associated with Passive Engineering Controls Leading to Accidental Criticality Accident Sequences
Criticality Accident Sequences that Involve Uranium Entering a System Not Intended for Uranium Service
Criticality Accident Sequences that Involve High Uranium Content in Side Waste Stream
Facility Fires and Explosions Leading to Uncontrolled Release of Fissile Material, High- and Low-Dose Radionuclides
Radiological Accident Sequences in Confinement Boundaries (including Ventilation Systems)
Administratively Controlled Enrichment, Mass, Container Volume, and Interaction Limit Process Upsets Leading to Accidental Criticality Accident Sequences
Receipt and Shipping Events
Natural Phenomenon and Man-Made Events on Safety Features and Items Relied on for Safety

Shielding Analysis

- Source terms were calculated based on radionuclide inventory for various process streams
- SCALE v6.1.3 version of ORIGEN-S code was used to decay stream radionuclide inventories and generate photon source spectra
- Dose rates were computed using ICRP 74 flux-to-dose conversion factors in rotational geometry
- Shielding process
  - Monte Carlo N-Particle (MCNP) model was used to evaluate process components
    - Materials, geometry, source term
    - Tallies, variance reduction
    - Calculation, post-process
    - Five process areas considered
- Shield wall design was completed
  - Deep penetration problem requiring advanced variance reduction, elaborate source description
  - Hot cell penetrations analyzed

Criticality Analysis

- "First principles" were used as bases for equipment design and process area layouts
  - Geometry constraints (e.g., pencil tank diameters)
  - Tank array spacing (conservative)
  - Transition from "safe-geometry" process equipment to less-restricted waste staging and processing equipment was considered
- Evaluations and analysis
  - MCNP code validation and upper subcritical limits for all areas of applicability
    - Defined operation/process to identify range of parameters t
    - 92 criticality safety experiments
    - Defined area of applicability (AoA)
  - Project-specific single-parameter criticality limits for U enrichment, forms, and basic geometries
- Criticality safety evaluations (CSE)
  - Normal operating conditions described
  - Criticality hazard evaluation
  - Contingency analysis
  - Double contingency controls

Criticality Safety Evaluation Documents
Irradiated Target Handling and Disassembly
Irradiated LEU Target Dissolution
Mo-99 Recovery and Purification
LEU Target Material Production
Target Fabrication Uranium Solution Processes (Wet)
Target Fabrication (Dry)
Target/Can Storage and Cart
Uranium Recovery and Recycle
Liquid Waste Processing
Solid Waste Collection, Encapsulation, and Staging
Offgas and Ventilation
Target Transport Cask and Drum Handling
Analytical Laboratory
Calculations • *Single Parameter Subcritical Limits for 20 wt% ^{235}U - Uranium Metal, Uranium Oxide, and Homogenous Water Mixtures* • *Irradiated Target LEU Material Dissolution* • *55-Gallon Drum Arrays* • *Single Parameter Subcritical Limits for 20 wt% ^{235}U - LEU Target Material* • *Target Fabrication Tanks, Wet Processes, and Storage* • *Hot Cell Tank Pit*

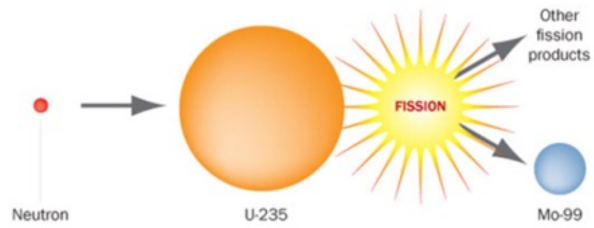
NWMI NORTHWEST MEDICAL ISOTOPES

Principal Design Criteria

- RPF design is based on applicable standards, guides, codes, and criteria and provides reasonable assurance that SSCs
  - Are built and will function as designed and required per Chapter 13.0, “Accident Analysis”
  - Ensure acceptable protection of public health and safety and environment from radiological risks (e.g., radioactive materials, exposure) resulting from operations
  - Protect against potential hydrological (water) damage
  - Protect against seismic damage
  - Provide surveillance activities and technical specifications required to respond to or mitigate consequences of seismic damage
  - Technical specifications will be developed to ensure that safety-related functions of electromechanical systems/components will be operable and protect human health and environment
- Defense-in-depth design philosophy → Applied from outset of facility design through completion of facility design/construction drawings
  - Based on providing successive levels of protection such that health and safety are not wholly dependent on any single element of design, construction, maintenance, or operation
  - Net effect of incorporating practices is a conservatively designed facility and systems that exhibit higher tolerances to failures and external challenges
  - Risk insights obtained through performance of accident analysis can then be used to supplement final design by focusing attention on prevention and mitigation of higher risk potential accidents

Comparison with Similar Facilities

- Established a network of domestic university research reactors to irradiate LEU targets
  - Nearly all of Mo-99 in supply chain today is produced by irradiating U-235 with neutrons (e.g., fission reaction with ~6% of collisions result in formation of Mo-99)



- RPF is a conventional design, similar to design used in other nuclear processing facilities
  - Dissolution of target material uses a standard hot nitric acid process
  - Offgas treatment unit operations are well known and commercially available
  - Mo recovery and purification system will use two different IX resins to selectively adsorb Mo from irradiated target solution
  - Uranium recovery process is a modification of a widely used uranium separation and purification process known as plutonium-uranium extraction (PUREX) → Process uses similar chemistry but instead of a solvent process, active agent is attached to a solid substrate
  - Target fabrication processes and techniques are used in uranium processing and fuel fabrication facilities in U.S. (e.g., standard nitric acid dissolution, small solvent extraction system, concentrator)
- Summary → RPF processes are well understood, reliable, predictable

Chapter 1 Questions?

Advisory Committee on Reactor Safeguards
Meeting on Northwest Medical Isotopes Construction Permit Application

Chapter 1
Introduction to the Facility

U.S. Nuclear Regulatory Commission
June 19, 2017

Introductions

- **Michael Balazik** - Project Manager, Research and Test Reactors Licensing Branch, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation

- **David Tiktinsky** - Senior Project Manager, Fuel Manufacturing Branch, Division of Fuel Cycle Safety, Safeguards, and Environmental Review, Office of Nuclear Material Safety and Safeguards

- **Alexander Adams, Jr.** - Chief, Research and Test Reactors Licensing Branch, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation

Northwest Medical Isotopes, LLC (NWMI)

- NWMI has requested a construction permit for a radioisotope production facility (RPF) in Columbia, Missouri
- If granted, permit would allow construction of a commercial production facility for molybdenum-99 (^{99}Mo)
- Fabricated targets to be transported to and irradiated at existing university research reactors (University of Missouri - Columbia, Oregon State University, and potentially a third facility)
- Several hot cell structures comprise the production facility, which will chemically separate ^{99}Mo as part of the Mo recovery and purification process

NWMI Radioisotope Production Facility

- RPF process descriptions
  - Target disassembly and dissolution
  - ^{99}Mo recovery and purification
  - Uranium recycle and recovery
  - Waste processing
- PSAR includes an Integrated Safety Analysis Summary and designated safety-related structures, systems, and components
- Hazard and accident analyses
- Preliminary Items Relied on for Safety (IROFS) developed

NRC Licensing Approach

- RPF consists of several hot cell structures, which meet the 10 CFR 50.2 definition of *production facility*

- 10 CFR 50.2 defines *production facility* as:
  - Any facility designed or used for the processing of irradiated materials containing special nuclear material…
    - E.g., Batch size greater than 100 grams of U-235

- While NRC has licensed production facilities, no such facilities currently operating
  - Issuance of SHINE construction permit (*utilization* and *production* facilities)
  - West Valley (licensed as a fuel reprocessing facility under 10 CFR Part 50)

NRC Licensing Approach (cont.)

- Technology involved in target fabrication activity similar to fuel manufacturing
  - Does not meet the definition of either a *utilization* or *production facility* (10 CFR Part 50) and not within scope of construction permit review
- 10 CFR Part 70 applies to target fabrication
  - Receive title to, own, acquire, deliver, receive, possess, use, and transfer SNM
  - Scrap recovery of SNM
  - 10 CFR Part 70, Subpart H requirements
  - Possess greater than critical mass of SNM
  - Fabrication processes and associated hazards similar to fuel-cycle facilities

Construction Permit Requirements

- Some regulations applicable to NWMI construction permit:
  - 10 CFR 50.22, Commercial and industrial facility licenses
  - 10 CFR 50.30, Environmental Report
  - 10 CFR 50.34(a), Preliminary safety analysis report
  - 10 CFR 20.1201, Occupational dose requirements
  - 10 CFR 20.1301, Public and accident dose requirements
  - 10 CFR 50.35, Issuance of construction permits
- 10 CFR 70.61, “Performance Requirements”
- 10 CFR Part 50, Appendices A, “General Design Criteria….,” and B, “Quality Assurance Criteria…,” only apply to nuclear power plants.
- 10 CFR Part 100, “Reactor Site Criteria,” siting and accident dose criteria only apply to nuclear power reactors and testing facilities.

Construction Permit Findings

- A construction permit may be issued per 10 CFR 50.35, if:
  - The applicant has described the proposed design, including the principal architectural and engineering criteria for the design and identified major features or components for the protection of the public health and safety
  - Further technical or design information that completes the safety analysis, and which can reasonably be left for later consideration, will be supplied in the FSAR
  - Safety features or components requiring research and development have been identified and the applicant will conduct a research and development program reasonably designed to resolve associated safety questions
  - There is reasonable assurance that safety questions will be resolved prior to the completion of construction and the proposed facility can be constructed and operated without undue risk to the health and safety of the public

Construction Permit Findings (cont.)

- Permit findings also include whether the following standards in 10 CFR 50.40 and 50.50 have been met:
  - There is reasonable assurance: (i) that construction of the facility will not endanger the health and safety of the public, and (ii) that construction activities can be conducted in compliance with the Commission's regulations
  - The applicant is technically and financially qualified to engage in the proposed activity
  - The issuance of a construction permit would not be inimical to the common defense and security or to the health and safety of the public
  - The applicable environmental requirements of subpart A of 10 CFR Part 51 have been satisfied
  - The application meets the standards and requirements of the AEA and the Commission's regulations, and that notifications, if any, to other agencies or bodies have been duly made

Construction Permit vs. Operating License

- Construction permit (10 CFR 50.35)
  - Allows licensee to proceed with construction based on preliminary design information
  - Does not approve of the safety of any design feature or specification unless specifically requested by the applicant

- Operating license (10 CFR 50.57)
  - Allows licensee to operate the facility based on final design
  - Issued when, among other things, construction of the facility is substantially completed in accordance with NRC requirements and there is reasonable assurance that the activities authorized by the license will not endanger the public health and safety

Regulatory Guidance and Acceptance Criteria

- NUREG-1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors”

- Interim Staff Guidance Augmenting NUREG-1537
  - Radioisotope production facilities
  - Aqueous homogeneous reactors
  - Incorporates relevant non-reactor guidance from NUREG-1520, “Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility, Rev. 1”

- Other guidance (e.g., regulatory guides and ANSI/ANS standards) and engineering judgment used, as appropriate, to make construction permit findings

NUREG-1537 Review Areas

1. The Facility/Introduction
2. Site Characteristics
3. **Design of Structures, Systems, and Components**
4. Facility Description
5. Coolant Systems
6. **Engineered Safety Features**
7. **Instrumentation and Control**
8. **Electrical Power Systems**
9. **Auxiliary Systems**
10. Experimental Facilities
11. **Radiation Protection and Waste Management**
12. **Conduct of Operations**
13. **Accident Analyses**
14. **Technical Specifications**
15. Financial Qualifications
16. Other License Considerations*
17. Decommissioning*
18. Uranium Conversions*
19. Environmental Review

*Not applicable to the NWMI construction permit application

BOLD – Chapters presented to ACRS Subcommittee

Summary of Chapter 1 Review

- Applicable requirements of Atomic Energy Act and Commission regulations have been met
- NWMI facility does not share any systems or equipment with other facilities
- RPF processes, such as ^{99}Mo purification and uranium recovery, are similar to other facilities
- NWMI facility will not have high-level nuclear waste or spent nuclear fuel, so Nuclear Waste Policy Act of 1982 is not applicable

Status of Safety Evaluation Report Development

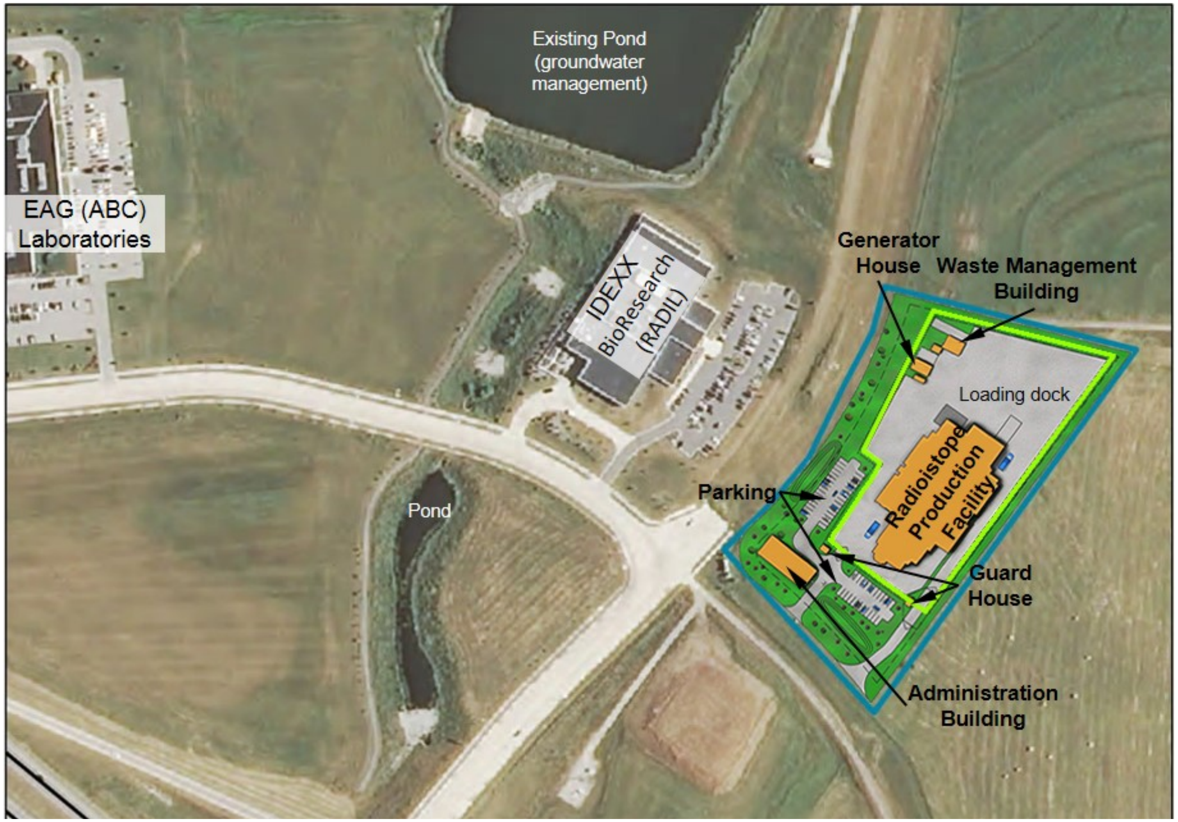
- Staff is nearing completion of technical review of NWMI PSAR

- NWMI submitted revised PSAR Chapters 1, 2, 4, and 5 incorporating RAI responses

- Presenting selected chapters that staff have determined are technically linked and complete

- Completion of Safety Evaluation Report by October 2017

U.S. Nuclear Regulatory Commission
ACRS Subcommittee Review



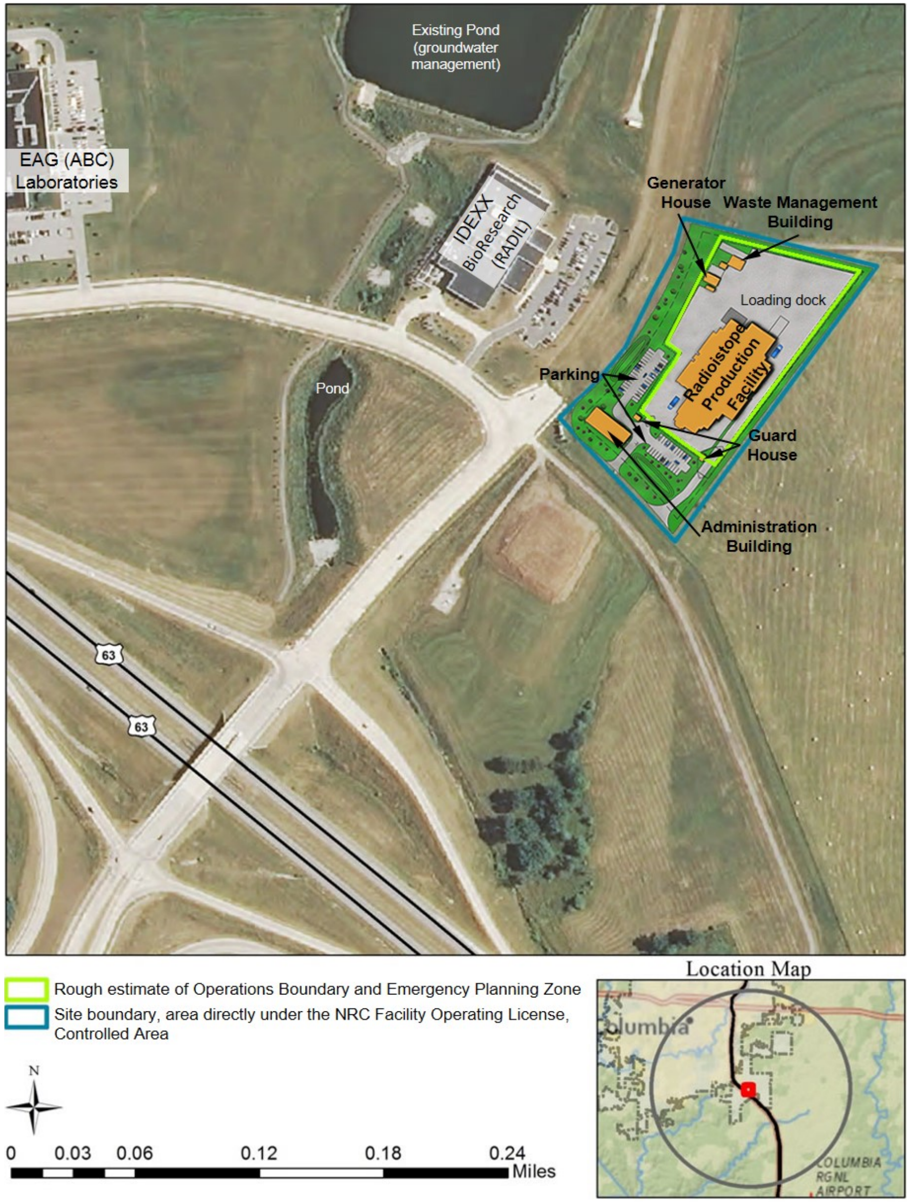
Chapter 2 – Site Characteristics

June 19, 2017

NWMI
NORTHWEST MEDICAL ISOTOPES

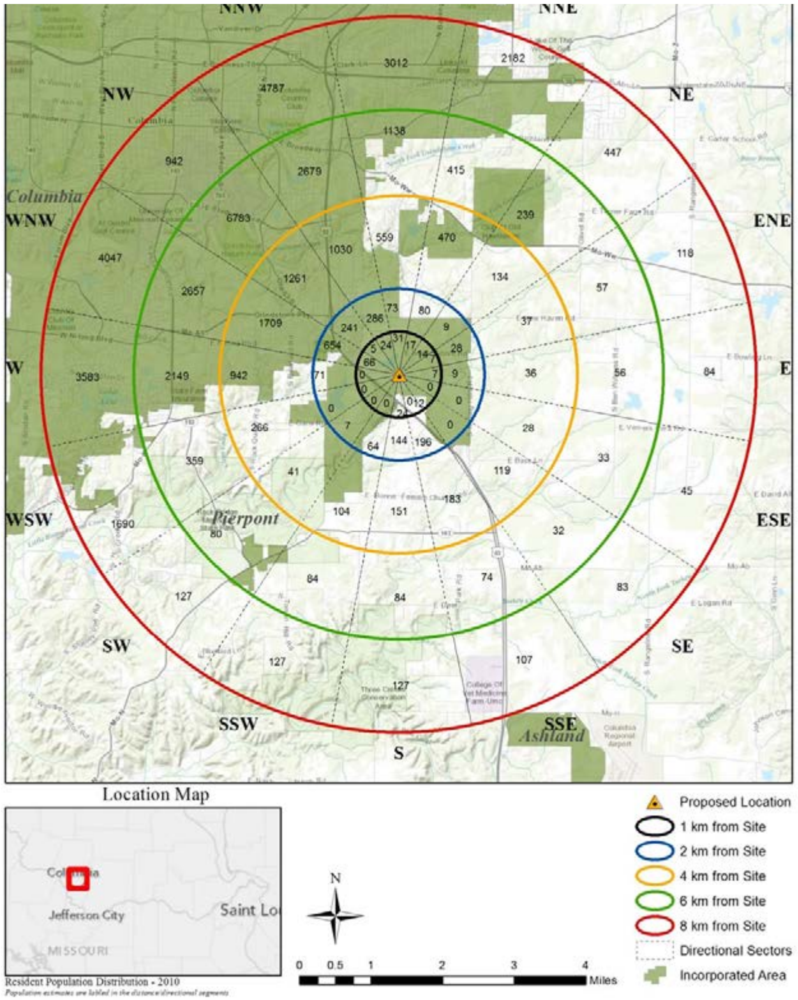
Site Location and Description

- Site is 7.4-acre
- Located in Boone County, Missouri, within University of Missouri (MU) Discovery Ridge Research Park (Discovery Ridge) in Columbia, Missouri,
- Site is located in central Missouri
  - ~125 miles east of Kansas City and ~125 miles west of St. Louis
  - 4.5 miles south of Interstate-70 and just to north of US Highway 63
  - 3.5 miles to southeast of main MU campus
  - 9.5 miles west Missouri River



Population Distribution within 5.0 Miles

- Information includes estimates of resident and transient populations for most recent census year (2010) and projects of resident and transient populations



Resident Population Distribution within 5 Miles of Site

Year	Distance band (km)					
	0 – 1	1 – 2	2 – 4	4 – 6	6 – 8	Total 0 – 8
2010	205	1,862	7,070	16,919	21,508	**47,564**
2014	218	1,974	7,495	17,936	22,801	**50,423**
2015	221	2,004	7,608	18,205	23,143	**51,181**
2019	234	2,124	8,063	19,296	24,530	**54,247**
2020	238	2,156	8,184	19,585	24,897	**55,060**
2045	291	2,628	9,991	23,948	30,428	**67,287**
2050	313	2,820	10,727	25,728	32,683	**72,271**

Nearby Facilities

An investigation of industrial, military, and transportation facilities from 8 km to 16 km was also conducted and identified following transportation facilities for further evaluation

Industrial Facilities

- 3M Company – Columbia
- AT&T, Inc.
- Columbia Municipal Power
- MPC #93

Major Waterways

- Missouri River

Pipelines

- Panhandle Eastern Pipeline Company

Fuel Storage Facilities

- Midway Auto Truck plaza
- Ballenger Propane, Inc.
- Ferrellgas

Airports

- Sugar Branch Airport – 15.6 km (9.7 mi) northwest of RPF
- Cedar Creek Airport – 10.6 km (6.6 mi) northeast of RPF
- Columbia Regional Airport – 10.4 km (6.5 mi) south of RPF

Helicopter Ports

- University of Missouri Hospitals and Clinics – 6 km (3.7 mi) northwest of RPF
- MU – 6 km (3.7 mi) northwest of RPF
- Boone Hospital Center – 6.3 km (3.9 mi) northwest of RPF

Nearby Facility Summary Information

Significant Industrial Facilities within 10 Miles of Site

Facility	Product	Distance from RPF km	Distance from RPF mi	Direction	Hazardous material
Gates Power Transmissions Materials Center	Vehicle and machinery drive belts	2.4	1.5	Northwest	• Toluene • Methyl ethyl ketone
MU South Farm	Agriculture	1.6	1	Northwest	• Diesel • Gasoline • Motor oil • Propane
Ryder Transportation	Rental trucks	2.4	1.5	South	• Diesel
3M Company	Electronic components	12.9	8	North	• Glycol ether PM
Schwan's Home Service	Food service	6.8	2.4	South	• Propane

Major Pipelines Located within 5 Miles of Site

Pipeline company	Product	Diameter cm	Diameter in.	Pressure (max) kPa	Pressure (max) lb/in.^{2}	Distance from RPF km	Distance from RPF mi	Direction
Ameren Missouri	Natural gas	21.8	8.6	9,652	1,400	6.0	3.75	North
Southern Star Central Gas Pipeline, Inc.	Natural gas	21.8	8.6	9,652	1,400	1.6	1	South
Magellan Midstream Partners, LP	Refined petroleum	66	26	5,930	860	2.5	1.5	North
Magellan Midstream Partners, LP	Empty	N/A	N/A	N/A	N/A	1.6	1	South/east

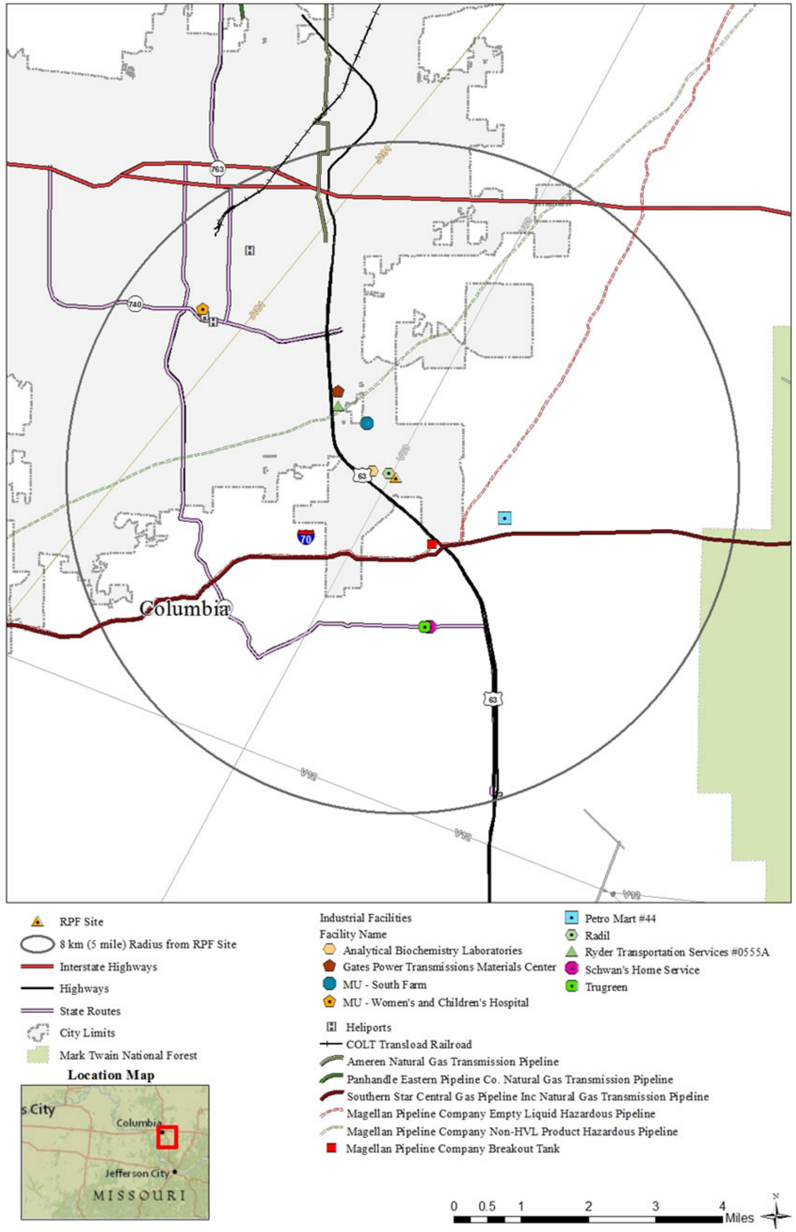
Major Storage Facilities Located within 5 Miles of Site

Storage facility	Product	Volume (gal)	Distance from RPF km	Distance from RPF mi	Direction
Magellan Pipeline Company Breakout Tanks	Refined petroleum	16,118,182	1.6	1	Southeast
Ferrellgas	Propane	28,000	8	5	North

Transportation

Estimated Potential Hazardous Chemical Within 5 Mile Radius of Site

Hazardous material	Quantity	
	kg	lb
Ammonia	22,680	50,000
Ammonium nitrate	22,680	50,000
Chlorine	408	900
Diesel	22,680	50,000
Gasoline	22,680	50,000
Glycol ether PM	22,680	50,000
Hydrofluorosilicic acid	22,680	50,000
Hydrogen	1,497	3,300
JP-4 aviation fuel	22,680	50,000
Methyl ethyl ketone	22,680	50,000
Oil	22,680	50,000
Pentaerythritol distearate	22,680	50,000
Petroleum naphtha	22,680	50,000
Propane	22,680	50,000
Sulfur dioxide	22,680	50,000
Toluene (32-8413)	22,680	50,000
Zetpol (all types)	22,680	50,000



Air Traffic

- Three airports and three helicopter ports located within 10 miles
- Based on NUREG 1537 sites located between 5 miles and 10 miles from an existing or projected commercial or military airport with more than approximately 200 d2 commercial or military aircraft movements per year → probability of aircraft accidents is considered less than an order of magnitude of 10^{-7} per year

200 D^2 Limits			
Airport	Distance km (mi)	Flights per year	200 d^2 limits[a]
Columbia Regional Airport	10.4 (6.5 mi)	16,610	21,632
Cedar Creek	10.6 (6.6 mi)	730	22,472
Sugar Branch	15.6 (9.7 mi)	365	48,672

Note: where d is distance in kilometers from airport to site (200 X distance squared)

- RPF site is not located within a trajectory of a runway of airport

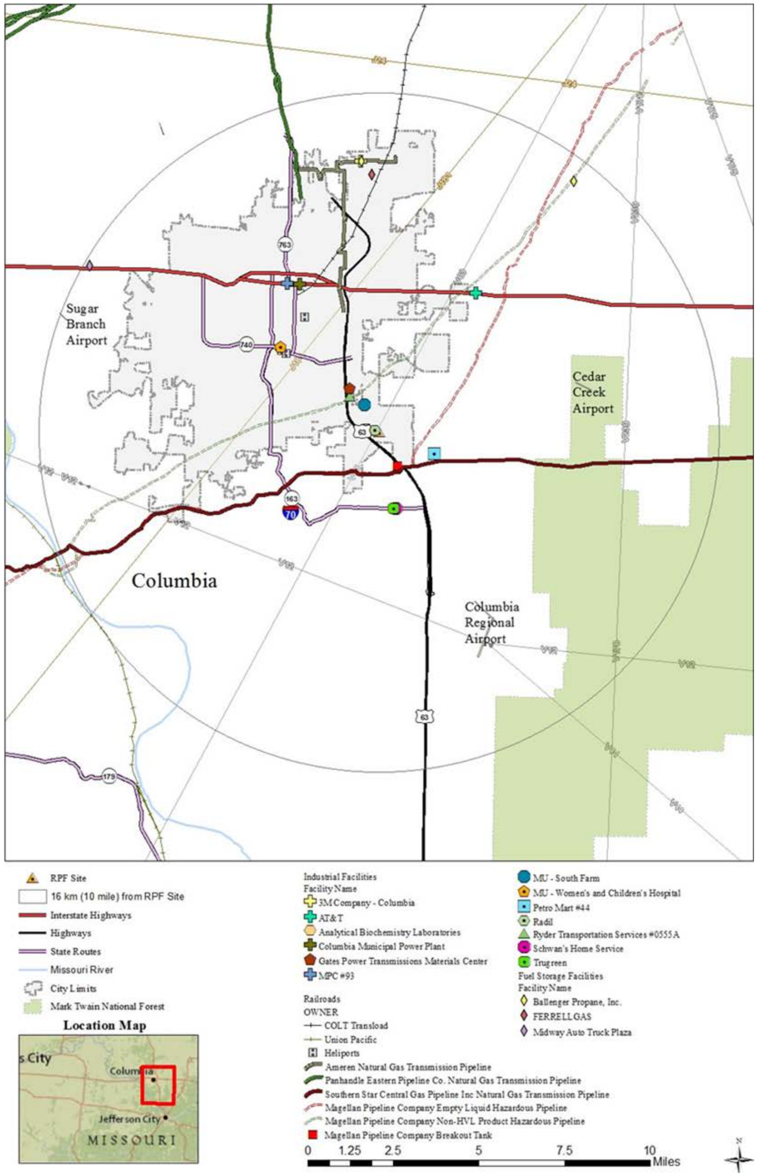
Air Traffic (con't)

- Since all 3 heliports are within 5 miles of site, frequency of an aircraft crashing into site was evaluated
- NUREG 0800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, Section 3.5.1.6, "Aircraft Hazards," provides a methodology for determining probability of an aircraft crash into a facility from airways
- However, approach requires knowledge of number of flights per year along airway
  - Due to information is not available for flight paths near site, DOE STD 3014 2006 (Accident Analysis for Aircraft Crash into Hazardous Facilities) was used to determine frequency of crashes
- Calculated crash impact frequency from heliports is < requirement of NUREG 0800 of being within an order of magnitude of 10^{-7} per year

No further analysis is required

Evaluation of Aircraft Hazard

- Seven federal airways located within 10 miles
- NUREG 1537
  - Requires evaluation of frequency and type of aircraft movement, flight patterns, local meteorology, and topography
- NUREG 0800, Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants (Section 3.5.1.6, Aircraft Hazards)
  - Used to evaluate airways near site
  - Indicates that an evaluation is not required when nearest edge of airway is greater than 2 miles from site
- Four of seven airways (J24, J181, V12, and V63) fall within 2 miles of site



Evaluation of Aircraft Hazard (con't)

Federal Designated Airways within 10 Miles of Site

Airway	Distanced from airway centerline to RPF		Airway width		Distance from airway edge to RPF	
	km	mi	km	mi	km	mi
J24	17.3	10.75	Not specified	Not specified	Within	Within
J181	4.8	3	Not specified	Not specified	Within	Within
V12	6.8	4.25	14.8	9.2	Within	Within
V44	11.2	7	14.8	9.2	3.5	4.0
V63	0.40	0.25	14.8	9.2	Within	Within
V175	19.3	12	14.8	9.2	2.2	2.5
V178/V239	11.2	7	14.8	9.2	2.6	3

- NUREG 0800, Section 3.5.1.6, provides a methodology for determining probability of an aircraft crash into a facility from airways
- However, approach requires knowledge of number of flights per year along airway
  - Due to information is not available for flight paths near site, DOE STD 3014 200696, Accident Analysis for Aircraft Crash into Hazardous Facilities, was used
  - This method uses crash rates for non-airport operations

Evaluation of Aircraft Hazard (con't)

- Crash impact probabilities from airways for five aircraft types are added to determine overall probability for small and large aircraft → Resulting probability is 7.28E-07
- NUREG-1537 does not provide acceptance criteria to be used to evaluate aircraft accident probability presented by nearby airways
- However, NUREG-0800 does provide criteria for assessment of aircraft accidents
  - For aircraft accidents, NUREG-0800, Section 3.5.1.6, states that "Aircraft accidents that could lead to radiological consequences in excess of exposure guidelines of 10 CFR 100 with a probability of occurrence greater than an order of magnitude of 10^{-7} per year should be considered in design of plant."
- Calculated crash impact probabilities from airways for all five aircraft types is less than an order of magnitude of 10^{-7} per year → Therefore, no future analysis is required

Effective Area Input Values and Calculated Effective Plant Area

Aircraft	[a]Average CONUS values $N_jP_jf_j(x,y)$	[a]Wing span WS (ft)	[a]cotΦ	Skid distance S (ft)	Effective plant area A_j (mi^2)	Non-airport crash frequency F_j
Air carrier	4E-7	98	10.2	1440	0.01569	6.27E-09
Air taxi	1E-6	59	10.2	1440	0.01303	1.30E-08
Large military	2E-7	223	9.7	[b]780	0.01561	3.12E-09
Small military	4E-6	78	10.4	[c]447	0.00705	2.82E-08
General aviation airplanes	2E-4	73	8.2	60	0.00338	6.77E-07

Analysis of Potential Accidents at Facilities

- Potential accidents to be considered as design-basis events and potential effects of those accidents on facility, in terms of design parameters (e.g., overpressure, missile energies) or physical phenomena (e.g., impact, flammable or toxic clouds), were identified
- Following accident categories were considered in selecting design-basis events:
  - Explosions
  - Flammable vapor clouds (delayed ignition)
  - Toxic chemicals
  - Fires
- Postulated accidents that would result in a chemical release were analyzed for following locations:
  - Nearby transportation routes such as U.S. Highway 63 and nearby natural gas pipelines
  - Nearby chemical and fuel storage facilities

Analysis of Potential Accidents at Facilities (con't)

- Analysis used TNT equivalency methodologies
- For all chemicals analyzed, minimum separation distances (i.e., safe standoff distances) are less than shortest distance (0.25 miles) to a safety-related RPF structure from any point on US Highway 63
- Peak incident pressure is 6.9 kPa (1 lb/in.2) at a distance greater than shortest distance from US Highway 63 to a safety-related RPF structure of 0.25 miles

Distance from Site Where Peak Incident Pressure is 1 1b/in^2
from an Explosion on US Highway 63

Hazardous material	Quantity		Acceptable distance peak incident pressure is 6.9 kPa (1 lb/in.^{2})	
	kg	lb	km	mi
Ammonia	22,680	50,000	0.27	0.17
Diesel	22,680	50,000	0.1	0.06
Gasoline	22,680	50,000	0.1	0.06
Glycol ether PM	22,680	50,000	0.1	0.06
Hydrogen	1,497	3,300	0.21	0.13
JP-4 aviation fuel	22,680	50,000	0.1	0.06
Methyl ethyl ketone	22,680	50,000	0.1	0.06
Petroleum naphtha	22,680	50,000	0.1	0.06
Propane	22,680	50,000	0.34	0.21
Toluene (32-8413)	22,680	50,000	0.1	0.06

Analysis of Potential Accidents at Facilities (con't)

Analysis show no explosion of any of these chemicals would not adversely affect RPF operations

- Conservative analysis using TNT equivalency methods was used to determine standoff distances for storage of identified hazardous materials
- Results indicate that minimum separation distances (i.e., safe standoff distances) are less than shortest distance from an RPF safety-related area to storage location of identified chemicals
- Other accidents/Impacts from Nearby Facilities were evaluated include:
  - On-Site Diesel Fuel Tank
  - Flammable Vapor Clouds (Delayed Ignition), numerous sources
  - Toxic Chemicals Impacts
  - Fires

Analysis of Hazardous Chemical Stored Within 5 Miles of Site

Hazardous material	Company	Distance		Mass		Acceptable distance (1 lb/in.^{2})	
		km	mi	kg	lb	km	mi
Glycol ether PM	3M Company	>8	>5	4,535,920	10,000,000	0.51	0.32
Propane	Schwan's Home Service Inc.	3.2	2	[a]77,250	[a]48,000	0.34	0.21
Toluene	Gates Power Transmissions Materials Center	2.4	1.5	45,359,200	100,000,000	0.91	0.57
Methyl ethyl ketone	Gates Power Transmissions Materials Center	2.4	1.5	22,679,620	50,000,000	0.44	0.7
Diesel	MU South Farm	1.6	1	22,679,620	50,000,000	[b]0.94	0.58
Gasoline	MU South Farm	1.6	1	4,535,920	10,000,000	0.44	0.27
Propane	MU South Farm	1.6	1	[c]226,796,200 (54,431)	[c]500,000,000 (120,000)	[c]7.42 (0.46)	[c]4.61 (0.29)
Diesel	Ryder Transportation	2.4	1.5	[a]24, 324	[a]53,625	0.096	0.06
Gasoline	Magellan Pipeline Company	1.7	1.1	[d]32,790,400 (8,572,895)	[d]72,290,455 (18,900,000)	0.55	0.34
Diesel	Magellan Pipeline Company	1.7	1.1	[e]14,152,081 (8,391,460)	[e]31,200,000 (18,500,000)	0.68	0.42

Meteorology

- Average temperature data for Columbia Missouri weather station was reviewed for most recent five years that data were available (2008 to 2012)
  - Lowest average temperature → 24.65°F (January 2010)
  - Highest average temperature → 85.06°F (July 2012)
  - Five year annual average temperature → 55.58°F
- Precipitation in Columbia, Missouri area
  - Average → ~40.6 in/year
  - Mean snowfall → 22.7 in/year
  - City has measurable amounts of precipitation 111 days/year
  - Maximum annual precipitation → 62.49 in (1993)
  - Minimum annual precipitation → 23.66 in (1980)
  - Monthly basis, rainfall amounts range from 4.89 in (May) to 1.82 in (January)
- Average relative humidity data for Columbia, MO weather station (2008 to 2012)
  - Lowest average relative humidity → 51.89% (August 2012)
  - Highest average relative humidity → 82.13% (September 2008)
  - Five year annual average → 69.18%

Meteorology (con't)

- Heartland of US is considered "Tornado Alley"
  - Non-meteorological term that references area where 90 percent of tornadoes have occurred as a result of mixing of cold, dry air from Canada and Rocky Mountains, with warm, moist air from Gulf of Mexico and hot, dry air from Sonoran Desert
- Tornado Alley exhibits a lot of atmospheric instability, heavy precipitation, and intense thunderstorms

Seasonal Frequency of Historical Tornadoes in Boone County, MO (1954 to 2016)

Month	Magnitude (Fujita Scale)			
	F0	F1	F2	F3
January	1	-	-	-
February	1	-	-	-
March	-	2	-	-
April	1	2	5	-
May	1	1	2	-
June	1	1	-	-
July	2	1	-	-
August	-	-	-	-
September	-	2	-	-
October	2	1	-	-
November	-	-	-	3
December	1	1	1	-

Meteorology (Con't)

Seasonal Thunderstorm Wind Events in Boone County, MO (1955 to 2016)

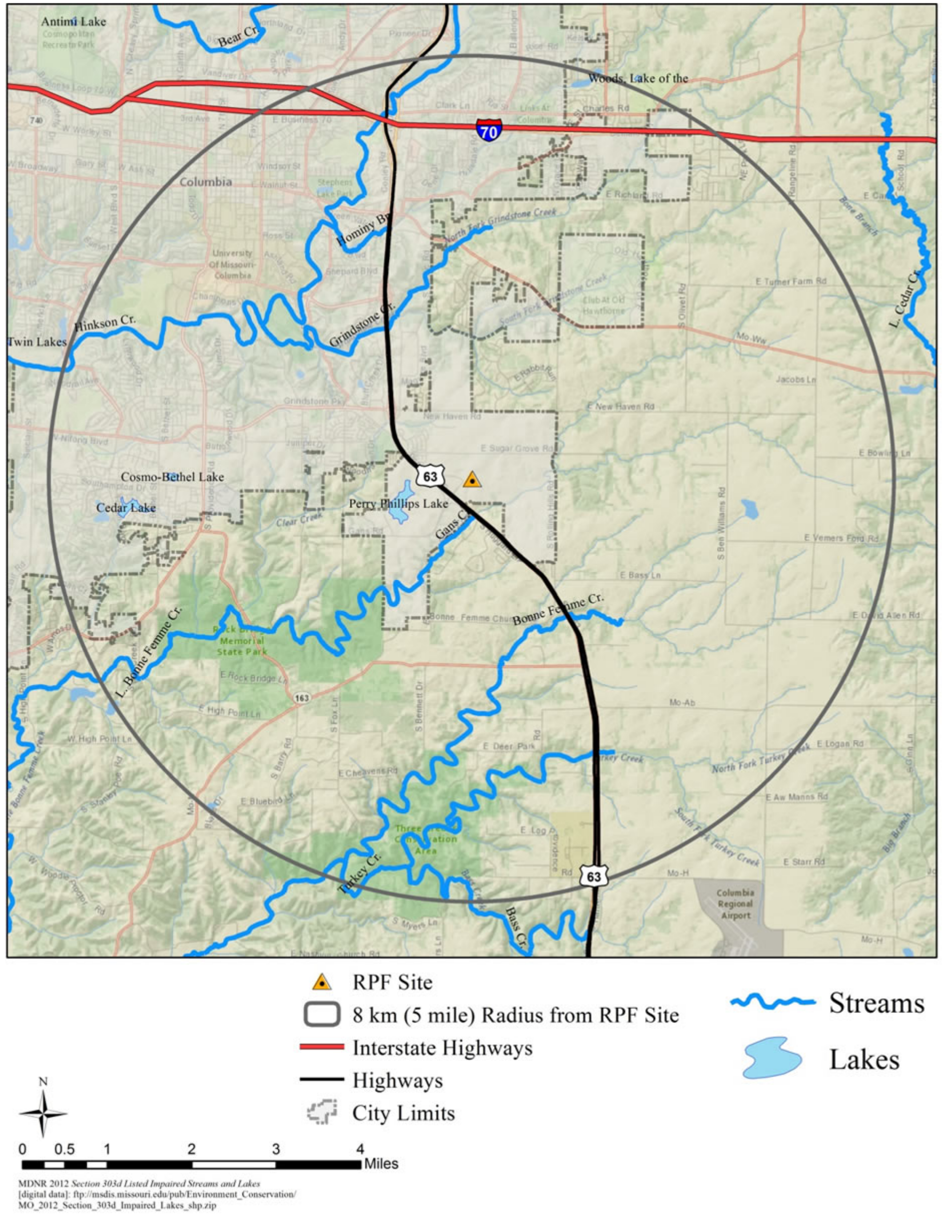
Month	Wind Velocity (mph)								
	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114
January	-	2	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-	-	-
March	-	8	1	3	2	-	-	-	-
April	-	12	5	2	2	-	-	1	-
May	-	13	7	9	3	2	1	1	2
June	-	20	3	6	3	1	1	2	-
July	-	12	8	10	6	1	2	2	-
August	1	18	6	2	3		1	1	-
September	-	4	1	3	-	-	-	-	-
October	-	-	-	-	-	-	-	-	-
November	-	-	1	-	-	-	-	1	-
December	-	2	-	-	-	-	-	-	-

Seasonal Hail Events in Boone County, MO (1958 to 2016)

Location	Diameter (in.)											Total
	0.75	0.88	1.00	1.25	1.50	1.75	2.00	2.50	2.75	3.00	4.00	
January	2	1	3	-	-	-	-	-	-	-	-	9
February	1	-	-	-	-	-	-	-	-	-	-	1
February	-	-	1	-	-	-	-	-	-	-	-	1
March	18	4	20	2	3	11	1	1	-	1	-	61
April	21	6	18	4	3	15	2	-	3	-	-	72
May	33	21	21	2	3	22	1	-	1	-	1	105
June	15	8	9	3	1	12	1	-	-	-	-	49
July	5	1	3	-	-	2	-	-	-	-	-	11
August	1	1	2	-	1	1	-	-	-	-	-	6
September	8	2	4	-	1	3	-	-	1	-	-	19
October	-	-	-	-	-	1	-	-	-	-	-	1
November	1	2	5	-	-	3	-	-	2	-	-	13
December	-	2	2	-	-	1	-	-	-	-	-	5

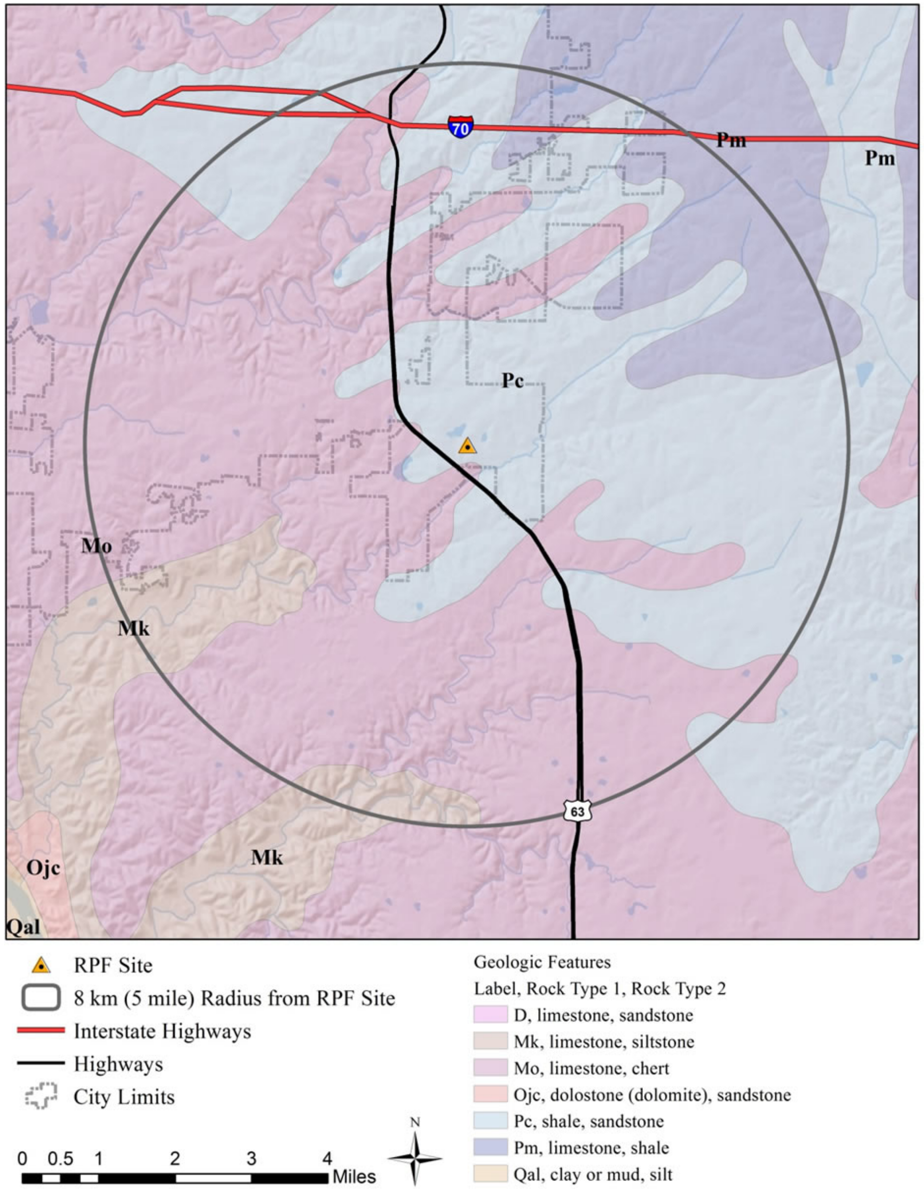
Hydrology

- Surface waters in central and southern Boone County drain into Missouri River through a number of tributaries
- Other major drainage feature of Bonne Femme Watershed includes a karst topography system west and south of site
- Numerous sinkholes, some filled with water, overlie a complex network of caves and springs
  - Gans Creek, which drains Discovery Ridge, is located within Bonne Femme Watershed
- Mississippian aquifer is principal aquifer supplying groundwater to Boone County
  - Estimated static water level near proposed site was approximately 650 ft below-ground surface
  - Groundwater depths range from 12–18.5 ft below-ground surface
- Site is located outside of 500 year flood plain
- Nearest FEMA flood zone A is located along Gans Creek located to southeast of site



Geology

- Site is located on the southern edge of the north of Missouri River within Interior Plains province (also referred to as Central Lowland province) and north of the Missouri River
- Landforms within this area as a whole are generally flat to gently rolling
- Topography mirrors this landform (e.g. flat to gently rolling) with a slope generally south to southwest
  - Local relief is 20 – 165 feet
- Surficial geology of Boone County is a product of glacial action and subsequent weathering and erosion
- Elevations range in Boone County range from 600-1,500 ft above mean sea level
  - Site ~805 ft above mean sea level



NWMI NORTHWEST MEDICAL ISOTOPES

Seismology

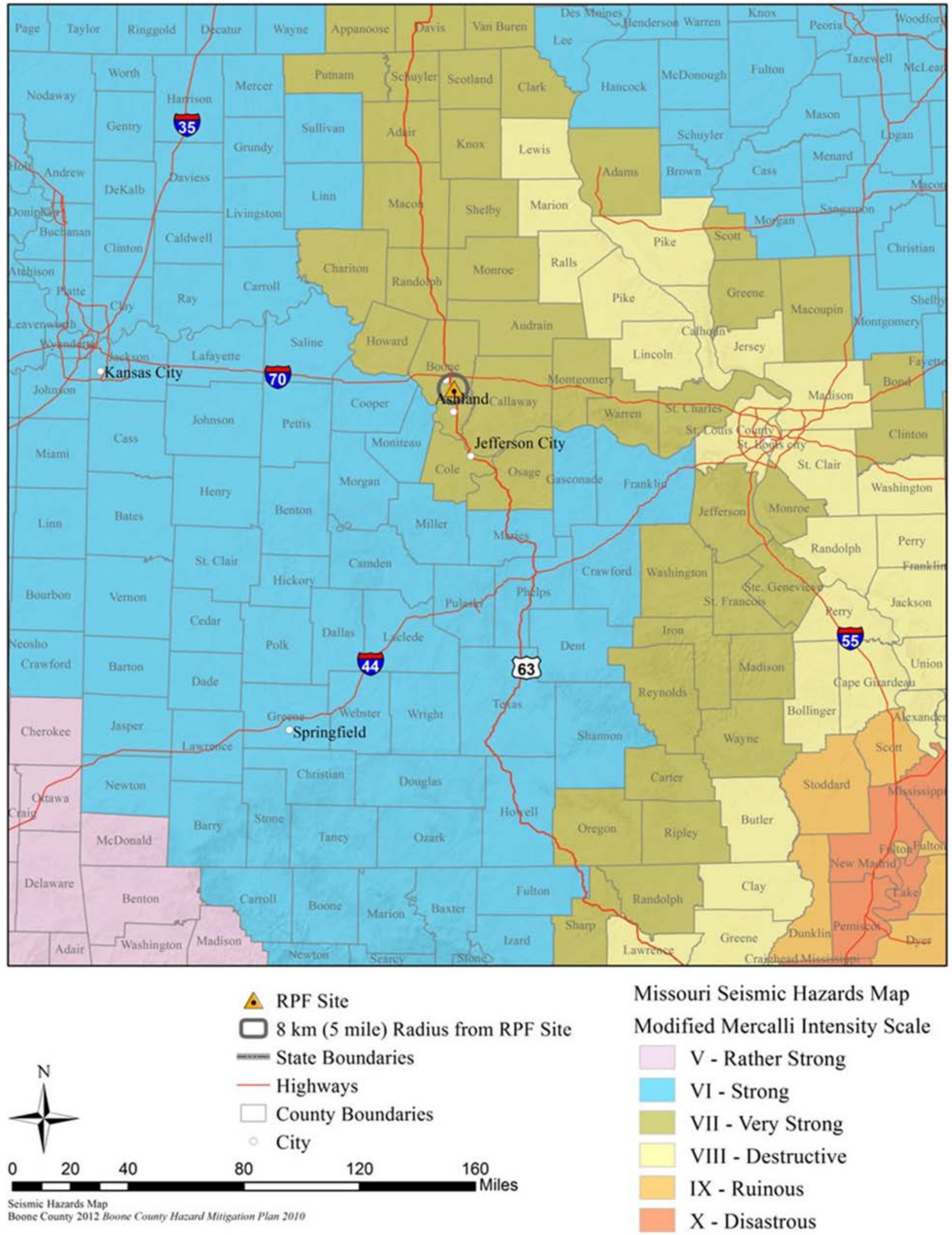
- Northeast Missouri is located within the central stable region of North American craton
- Region has a relatively gentle tectonic history since beginning of Paleozoic Era
- Higher tectonically active areas that border northeast Missouri to east and south (i.e., include Ozark Uplift, Mississippi Embayment and Ouachita Mountain System)
- Typical of central US, Discovery Ridge site is located within one a lower earthquake hazard areas in US → earthquake sources in southeast Missour (New Madrid Seismic Zone [NMSZ]) are primary diver of earthquake hazard in northeast Missouri
- In 2002, USGS released following projected hazards for Boone County, if an earthquake occurred along NMSZ in following 50 years

Projected Earthquake Hazards for Boone County, MO

Magnitude at NMSZ	Probability of occurrence (2002–2052)	Intensity in Boone County (MMI)	Expected damage
6.7	25–40%	VI, strong	Felt by all; many frightened and run outdoors, walk unsteadily. Windows, dishes, glassware broken; books fall off shelves; some heavy furniture moved or over-turned; a few instances of fallen plaster. Damage slight.
7.6	7–10%	VII, very strong	Difficult to stand; significant damage to poorly or badly designed buildings, adobe houses, old walls, spires, and other; damage would be slight to moderate in well-built buildings; numerous broken windows; weak chimneys break at roof lines; cornices from towers and high buildings fall; loose bricks fall from buildings; heavy furniture is overturned and damaged; and some sand and gravel streambanks cave in.

Seismology

- NWMI is committed to use similar seismic criteria as Calloway Nuclear Power Plant
- Estimated maximum ground acceleration at RPF will meet Regulatory Guide 1.60, Design Response Spectra for Seismic Design of Nuclear Power Plants, free-field response spectrum anchored to a peak ground acceleration of 0.20 g
- Additional geotechnical analysis is being at site to determine liquefaction potential of soils onsite



Chapter 2 Questions?

United States Nuclear Regulatory Commission
Protecting People and the Environment

Advisory Committee on Reactor Safeguards
Meeting on Northwest Medical Isotopes Construction Permit Application

Chapter 2
Site Characteristics

U.S. Nuclear Regulatory Commission
June 19, 2017

Introductions

- **Michael Balazik** - Project Manager, Research and Test Reactors Licensing Branch, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation

- **David Tiktinsky** - Senior Project Manager, Fuel Manufacturing Branch, Division of Fuel Cycle Safety, Safeguards, and Environmental Review, Office of Nuclear Material Safety and Safeguards

- **Alexander Adams, Jr.** - Chief, Research and Test Reactors Licensing Branch, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation

- **Enver Odar** - Technical Reviewer, SC&A

Site Characteristics

Site characteristics include the geographical, geological, seismological, hydrological, and meteorological characteristics of the site and vicinity in conjunction with present and projected population distributions, industrial facilities and land use, and site activities and controls.

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements
  - 10 CFR 50.34(a)(4), “Contents of applications”
  - 10 CFR 50.35, “Issuance of construction permits”
- Acceptance Criteria
  - NUREG-1537, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria”
  - Final Interim Staff Guidance (ISG) Augmenting NUREG-1537, Part 2, for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors

Areas of Review

- Areas of review included geography and demography; nearby industrial, transportation, and military facilities; meteorology; hydrology; and geology, seismology, and geotechnical engineering

- This chapter provides the external hazards and natural phenomena information used for the design basis of the facility and accident analysis

Summary of Application

- The Northwest Medical Isotopes (NWMI) radioisotope production facility would be within the University of Missouri (MU) Discovery Ridge Research Park in Columbia, Missouri. The site boundaries encompass approximately 7.4 acres of land.

- The area within 8 km (5 mi) of the NWMI site supports a population estimated to be about 68,710 (2010) people, who mostly live in the city of Columbia, Missouri.

Review Procedures and Technical Evaluation

The staff performed an evaluation of the siting information presented in Chapter 2 of the NWMI preliminary safety analysis report (PSAR), to assess the sufficiency of the preliminary design and performance of the NWMI facility in support of the issuance of a construction permit.

Review Procedures and Technical Evaluation

- Geography and Demography
- Nearby Industrial, Transportation, and Military Facilities
- Meteorology
- Hydrology
- Geology, Seismology, and Geotechnical Engineering

Geography and Demography

- PSAR distance-direction relationships to area boundaries, roads, railways, waterways, and other significant features were independently verified using a third-party-supplied map (i.e., Google Maps)

- Based on the distances provided in the NWMI PSAR, the staff confirmed that the nearest resident is about 0.3 miles from the site

- Staff finds:
  - Level of detail is adequate to provide an accurate description of the geography surrounding the facility
  - Demographic information is sufficient to allow an accurate assessment of the potential radiological risks to the public from the facility
  - Reasonable assurance that no geographic or demographic features render the site unsuitable
  - Findings consistent with findings from the NRC's Final Environmental Impact Statement (NUREG-2209) dated May 2017

Nearby Industrial, Transportation and Military Facilities

- Staff concluded that hazards posed by nearby manmade stationary facilities and transportation have been described and analyzed to the extent necessary to evaluate the potential risks. Locations were confirmed using a third-party-supplied map (e.g., Google Maps).
- Applicant evaluated risks from aircrafts
  - NWMI assessed the three heliports and three airports that are within 16 km of the site
  - NWMI determined that the crash impact frequency from the heliports are less that NUREG-0800 guidance of being within an order of magnitude of 10^{-7} per year and no additional analyses were needed
- Staff finds:
  - Reasonable assurance that nearby facilities and activities would not affect NWMI operations which is consistent with the accident evaluations in Chapter 13 of the PSAR

Meteorology

- Staff concluded that sufficient meteorological data has been provided to support the necessary analyses, including the predicted frequencies of recurrence and intensities of severe weather conditions
- PSAR meteorological data consistent with a year’s worth of data (2013) from an independent source
- Staff finds:
  - Meteorological history and projections are acceptable
    - These projections have been factored into the choice of facility location and design
  - Meteorological information is sufficient for the analyses commensurate with the facility risk
  - Methods and assumptions are applied to releases from normal operations and postulated accidents as shown in Chapter 13 of the PSAR

Hydrology

- The NRC staff concluded that the applicant provided sufficient information regarding the general hydrogeological characteristics of the proposed site to allow an independent review of hydrologically related design bases
- Staff finds:
  - Applicant considered hydrologic events of credible frequency and consequences in selecting the site
  - Applicant considered credible hydrologic events in developing design bases for facility
  - The integrated safety analysis (ISA) evaluated accidents related to hydrologic events and there is reasonable assurance that the performance requirements of 10 CFR 70.61 can be met as shown in the ISA summary and Chapter 13 of the PSAR

Geology, Seismology, and Geotechnical Engineering

- The staff concluded that the applicant provided sufficient information regarding the regional and site geology, seismicity, maximum earthquake potential, vibratory ground motion, and surface faulting, to allow an independent review
- Staff finds:
  - Applicant provided sufficient information on the geologic features and potential seismic activity at the site
  - Seismic events have been evaluated in the ISA and are discussed in Chapter 3.4 of the PSAR
  - No significant likelihood that the public would be subject to undue radiological risk following a seismic event that would make the site unsuitable for the proposed facility

Note: Additional geotechnical analyses to determine liquefaction potential will be performed and submitted with the operating license application

Evaluation Findings and Conclusions

- Accordingly, NWMI has met the following requirements of 10 CFR 50.35 for issuance of a construction permit:

  1) Radioisotope production facility systems have been described, including the principal architectural and engineering criteria

  2) Further technical or design information may be reasonably left for later consideration in the FSAR

  3) Reasonable assurance, based on Chapter 2 review, that the proposed facility can be constructed and operated without undue risk to the health and safety of the public

U.S. Nuclear Regulatory Commission
ACRS Subcommittee Review

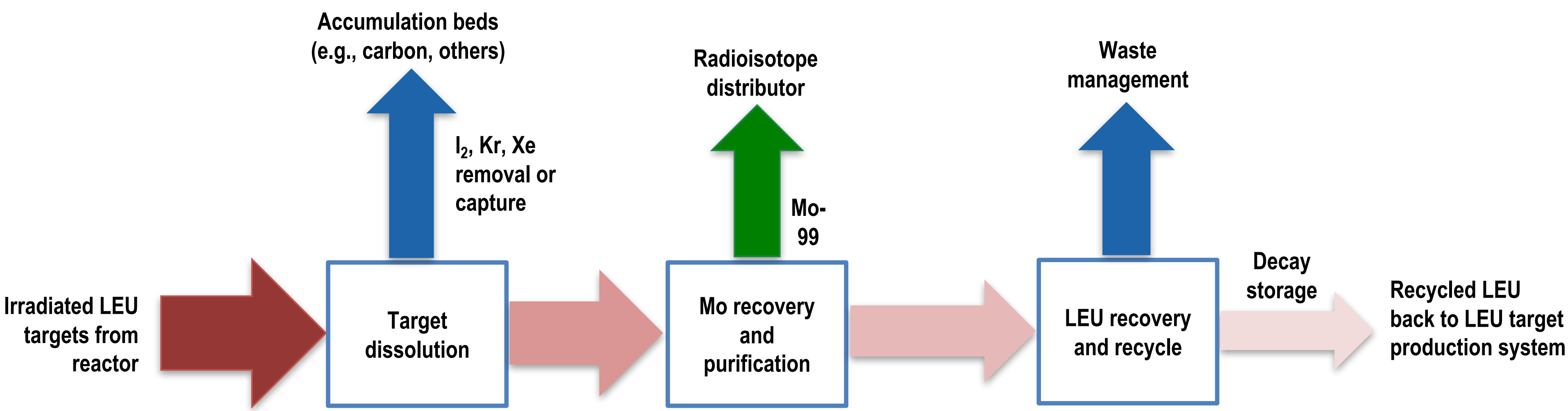
Chapter 4 – Facility Description

June 19, 2017

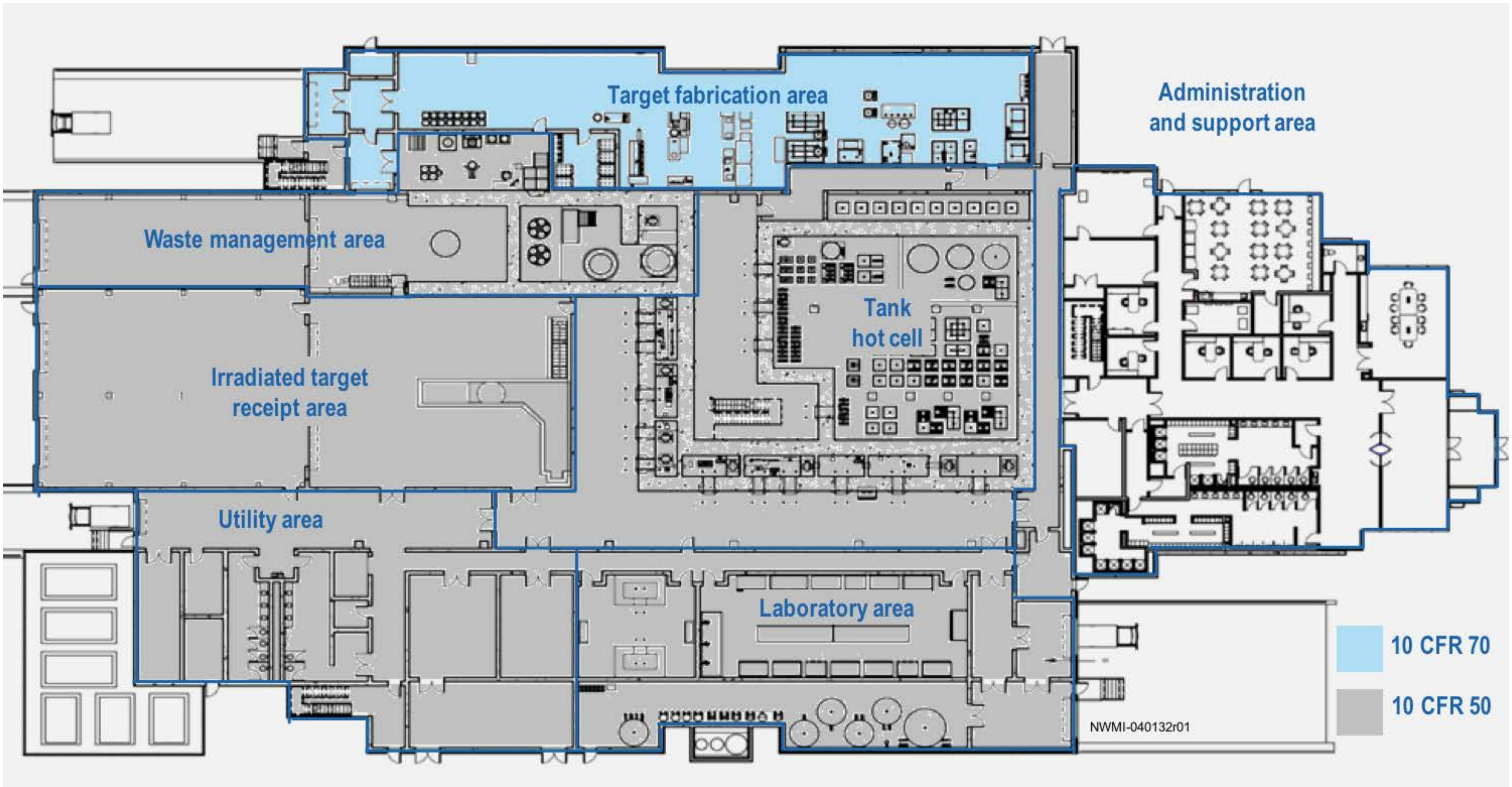
Site Plot Plan

Primary Assumptions

- Single radioisotope production facility → RPF
  - RPF includes target fabrication, Mo-99 production, and uranium recycle and recovery
    - Simple/straightforward chemistry processes
  - Mo-99 produced using a fission-based method – "Gold Standard" using LEU
  - Nominal capacity 3,500 6-day Ci; surge capacity of 1,500 6-day Ci
- Use network of university reactors
  - Use same target design for all reactors
  - Intellectual Property obtained
    - U.S., Australia, Russia, South Africa, Korea → Allowed
    - India, Europe, China → Pending
- Fission product releases will comply with environmental release criteria
- Generate Class A, B, and C wastes; no greater than Class C (GTCC) waste



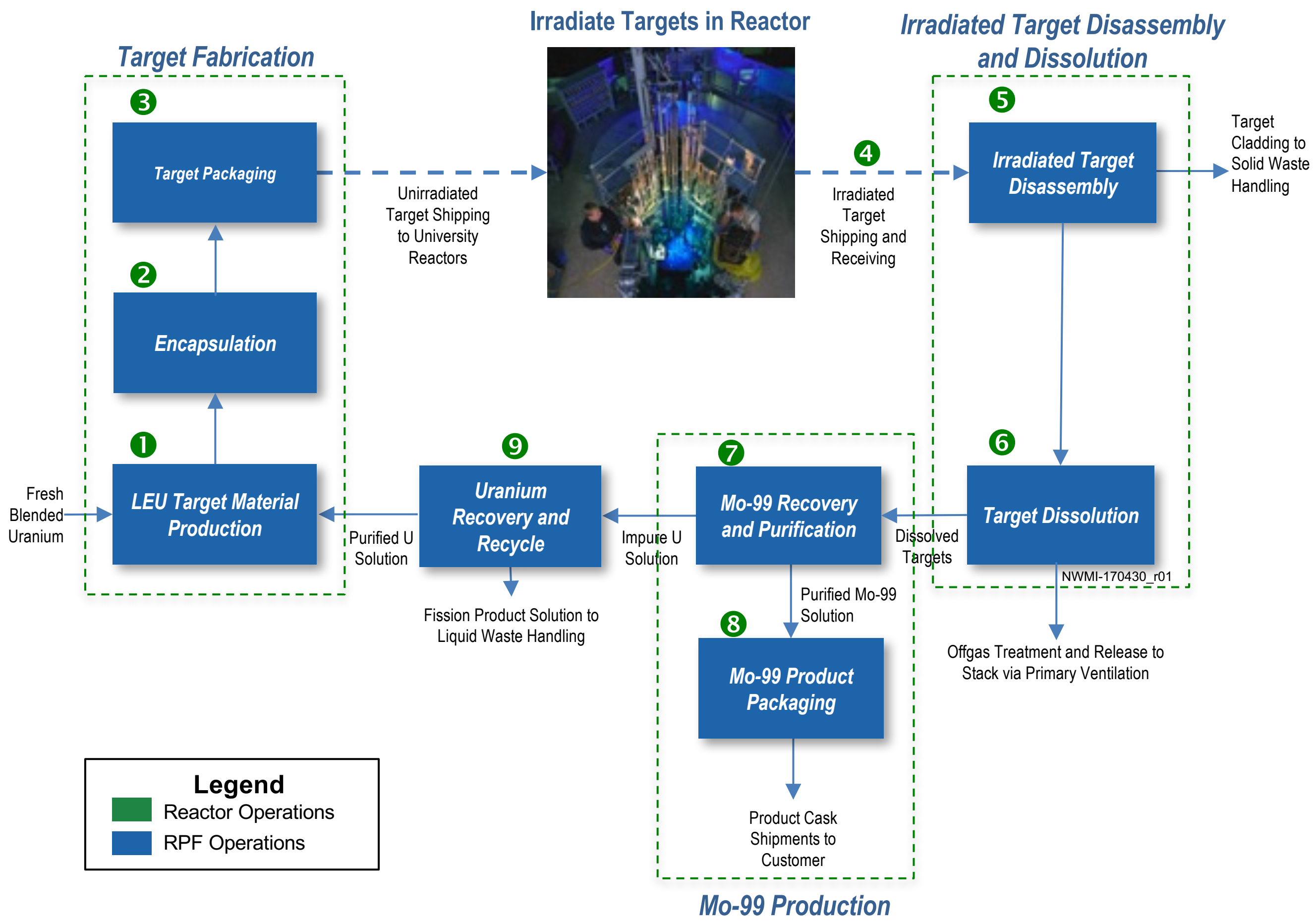
Radioisotope Production Facility Layout



Facility Description

- First level footprint ~52,000 ft^2
  - Target fabrication area
  - Hot cell processing area (dissolution, ^{99}Mo, and ^{235}U recovery)
  - Waste management, laboratory and utility areas
- Basement ~2,000 ft^2 (tank hot cell, decay vault)
- Second level ~17,000 ft^2 (utility, ventilation, offgas equipment)
- Waste Management Building ~1,200 ft^2
- Administration Building (outside of secured RPF area) ~10,000 ft^2
- High bay roof – 65 ft
- Mechanical area, second floor – 46 ft
- Top of exhaust stack – 75 ft
- Loading dock (back) roof – 20 ft
- Support and admin (front) roof – 12 ft
- Depth below grade for hot cell/high-integrity container (HIC) storage – 15 ft

RPF Process Flow Diagram



1. LEU target material is fabricated (both fresh LEU and recycled U)
2. LEU target material encapsulated using metal cladding → LEU target
3. LEU targets are packaged and shipped to university reactors for irradiation
4. After irradiation, targets are shipped back to RPF
5. Irradiated LEU targets disassembled
6. Irradiated LEU targets dissolved into a solution for processing
7. Dissolved LEU solution is processed to recover and purify Mo-99
8. Purified Mo-99 is packaged/shipped to a radiopharmaceutical distributor
9. LEU solution is treated to recover U and is recycled back to Step 1

Target Fabrication Summary – Steps ❶, ❷, and ❸

- LEU Target Material Production (Step ❶) (internal gelation process)
  1. Recycled uranyl nitrate is mixed with uranyl nitrate produced by dissolution of fresh U metal and is converted to ADUN using a solvent extraction process (selectively removes nitrate ions from solution)
  2. Resulting ADUN is evaporated to achieve desired uranium concentration and chilled before mixing with urea and HMTA to form a gelation broth
  3. Broth is then injected into a column of heated silicone oil
  4. LEU target material is filtered out from silicon oil (at column base) and washed with a solvent, ammonium hydroxide, and water
  5. LEU target material is then reduced in a stream of dilute hydrogen within a furnace at a high temperature
  6. Finally, LEU target material is sampled and analyzed to ensure that it meets all quality requirements

Acronyms
ADUN – acid-deficient uranyl nitrate
HMTA – hydroxymethyltetramine

Target Fabrication Summary – Steps ❶, ❷, and ❸ (cont.)

- Encapsulation (Step ❷)
  1. Target hardware is prefabricated and cleaned before entering RPF
  2. Targets are filled with LEU target materials and helium cover gas
  3. Once targets have been loaded and welded, they undergo inspection and quality assurance (QA) checks, including leak testing
  4. Targets that pass QA checks are shipped to University reactors for irradiation
  5. Targets that fail QA checks are disassembled and LEU target material is recycled, and hardware is cleaned and disposed of as nonradioactive scrap
- Target packaging and shipment (Step ❸)
  1. Assembled targets are loaded into shipping casks for transport to University reactors
  2. Transport will be via ground transportation

Convert fresh and recycled uranium into LEU target material and then load into target hardware for shipping to university reactors for irradiation

Requires no shielding; all equipment is contact-handled

Target Receipt, Disassembly, and Dissolution – Steps ❹, ❺, and ❻

- Target receipt and disassembly (Steps ❹ and ❺)
  1. Irradiated targets are received in shielded shipping casks
  2. Irradiated LEU targets are moved into hot cell via a below-grade tunnel to hot cell access point that mates up with either shipping cask or a transfer cask
  3. Targets are disassembled by puncturing target, collecting any fission product gases, opening target, and transferring irradiated LEU target material into a transfer container

  Spent target hardware is inspected and disposed of as solid waste

- Target dissolution (Step ❻)
  1. Irradiated LEU target material is transferred into a dissolver and dissolved in hot nitric acid → operated in a "batch" fashion
  2. Dissolver solution is diluted, cooled, filtered, and pumped to Mo-99 system feed tank
  3. Offgas will go through a series of cleanup columns
     - Nitrogen oxides (NO_x) is removed by a reflux condenser and several NO_x absorbers
     - Fission product gases (noble and iodine) are captured on absorbers
     - Remaining offgas is discharged into process ventilation header

Mo-99 Product Recovery and Purification System (Steps ❼ and ❽)

- Mo-99 recovery and purification (Step ❼)
  1. Dissolver solution is pumped through 1st IX column (Mo-99 recovery)
     - Mo-99 and trace components are absorbed onto IX media
     - U and most of fission products contaminants flow through column and are sent to U lag storage tanks
  2. Mo-99 is eluted from first column and purified in 2nd and 3rd IX column
     - Product purification process primarily consists of a series of chemical adjustments and IX columns to remove unwanted isotopes from Mo-99 product solution
     - Remaining waste solutions will be sampled and sent to low- or high-dose waste storage tanks
- Mo-99 product packaging and shipping (Step ❽)
  1. Product solution is sampled to verify compliance with radiopharmaceutical acceptance criteria
  2. Product solution is put in clean vials and then placed into shipping container liner in hot cell then transferred outside hot cell and loaded in to shipping containers
  3. Shipping containers are surveyed and manifested for transport Mo-99 product is transported via air or ground transportation depending on which radiopharmaceutical distributor is receiving shipment

Uranium Recovery and Recycle Summary (Step ⑨)

- 1st Stage U Recovery
  1. 1st stage Mo-99 IX column LEU stream is held in lag storage tanks to allow decay of select radionuclides
  2. Decayed U solution is diluted and pumped through 1st stage IX columns to separate bulk fission product contaminants
  3. U is eluted from IX columns, and concentrator/condenser is then used to concentrate eluate for 2nd stage IX U recovery

     Waste (from step 2) is sampled and sent to high-dose liquid waste accumulation tank
     Condensate is sent to low-dose liquid waste accumulation tank
- 2nd Stage U Recovery
  1. Interim U product solution is processed through a 2nd stage IX column to remove trace contaminants
  2. U is eluted from IX columns, and a concentrator/condenser is used to control volume of recycled U product
  3. Final U product solution is sampled to confirm that it meets recycle specifications

     Waste is sampled and sent to high-dose liquid waste accumulation tank
     Condensate is sent to low-dose liquid waste accumulation tank
- Product U lag storage → Allows for ^{237}U decay in U product solutions to contact-handled levels, then returned to target fabrication system

Waste Management System (3 Subsystems)

1. Liquid Waste System
   - Consists of storage tanks for accumulating waste liquids and adjusting waste composition
   - Split into high-dose and low-dose streams by concentration
     - High-dose fraction is further concentrated, adjusted, and mixed with adsorbent material
     - Portion of low-dose fraction is expected to be suitable for recycle to selected systems as process water
     - Water that is not recycled is adjusted and then mixed with an adsorbent material
     - Both solidified streams are held for decay and then shipped to a disposal facility
2. Solid Waste System
   - Consists of an area for collection and staging of solid wastes
   - Solids placed in waste drums and encapsulated by adding cement material to fill any voids
   - Will be held for decay and then shipped to a disposal facility
3. Specialty Waste System
   - Addresses small quantities of unique wastes generated (e.g., solvent waste, silicone oil, facility maintenance fluids, spent batteries/fluorescent lighting tubes, personal protective equipment)
   - Waste streams are containerized, stabilized, and shipped offsite for treatment and disposal
   - Goal is to reuse specialized waste to reduce waste and operational costs

Process Offgas Systems

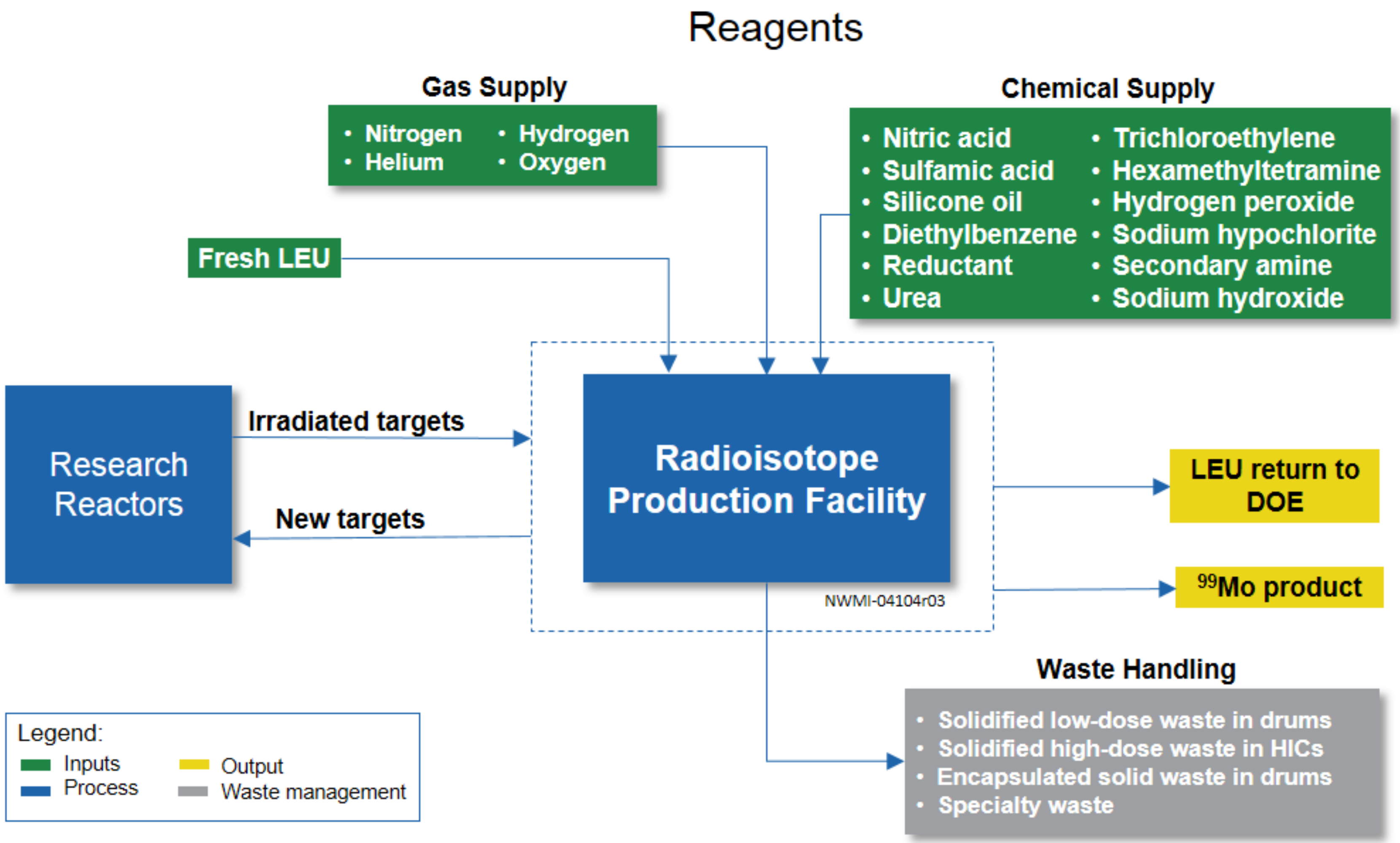
- Dissolver offgas subsystem
  - Connected directly to process vessels associated with irradiated target dissolution process and is located in hot cell tank pit
  - Two primary features
    1. Recover NO_x from nitric acid dissolution of irradiated targets
    2. Capture fission product gases released from irradiated targets
- Iodine potential offgas subsystem
  - Connected directly to process vessels or equipment that contain tellurium isotopes that decay and form iodine isotopes
  - Iodine capture system is included to ensure that any iodine evolving from process is captured on treatment media
- LEU target/target fabrication offgas subsystem
  - Connected directly to process vessels and equipment that are associated with LEU material production of target fabrication process → primary process is general offgas filtration
  - Controls/design features are required to maintain reducing gas within flammability limits

All offgas systems are connected directly to process vessels and maintains a negative pressure
All subsystems merge together at process offgas filter train

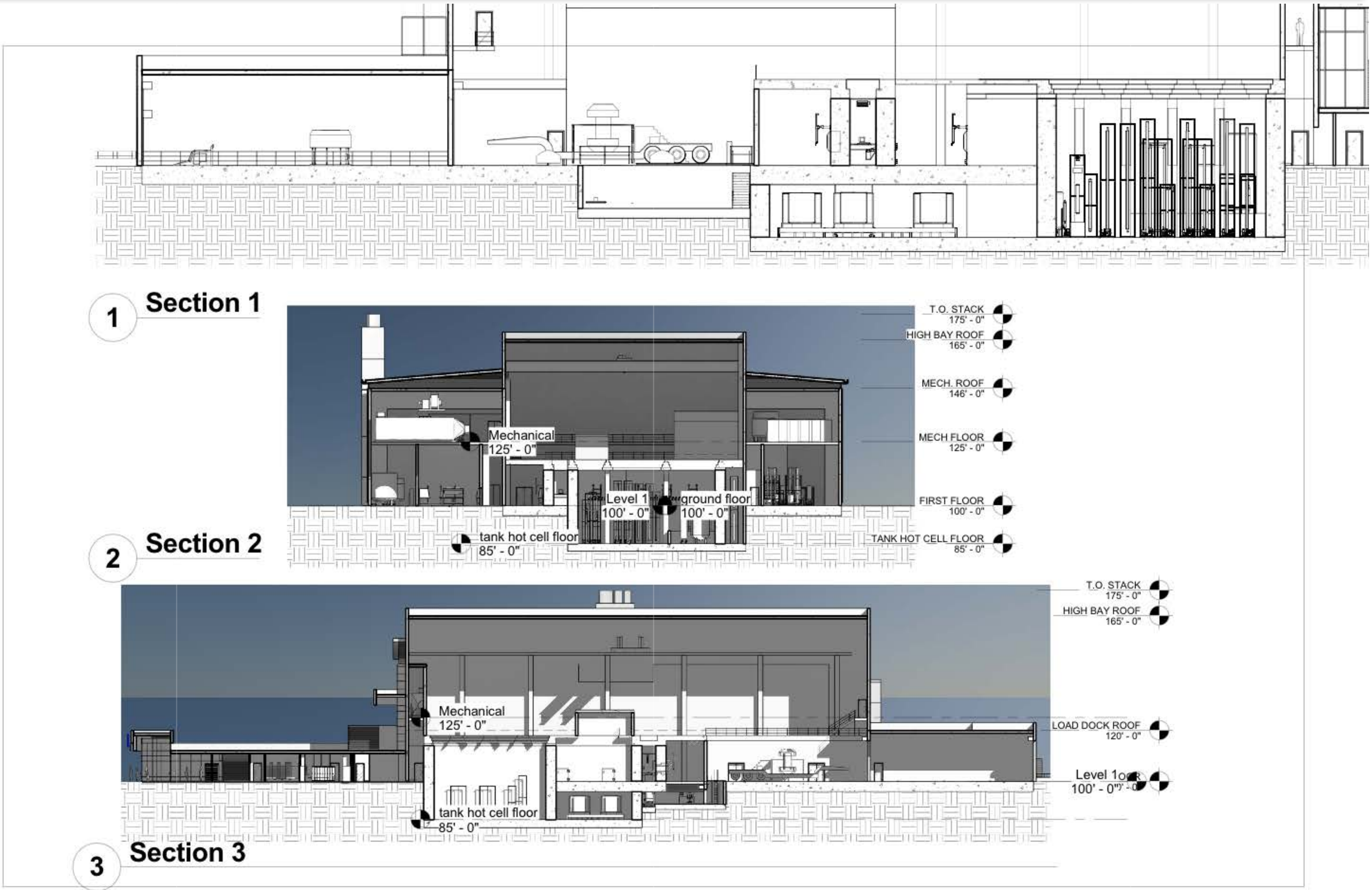
Ventilation – Four Confinement Zones

- **Zone I** – Initial confinement barrier
  - Includes gloveboxes, fume hoods, open front gloveboxes, vessels, tanks, piping, hot cells and Zone I exhaust subsystem
- **Zone II** – Secondary confinement subsystem
  - Includes walls, floors, ceilings, and doors of laboratories containing gloveboxes, high-efficiency particulate air (HEPA) filter rooms, and Zone II ventilation exhaust subsystem
- **Zone III** – Tertiary confinement barrier
  - Includes walls floor, ceilings and doors of corridor that surrounds operating galleries and mechanical mezzanine
- **Zone IV** – Traditional confinement zone and is reserved for characterizing positively pressurized areas, served by unitary, non-safety, and commercial-grade equipment
  - Includes administration support area, truck bays, and maintenance utility areas

Reagent, Product, and Waste Summary Flow Diagram

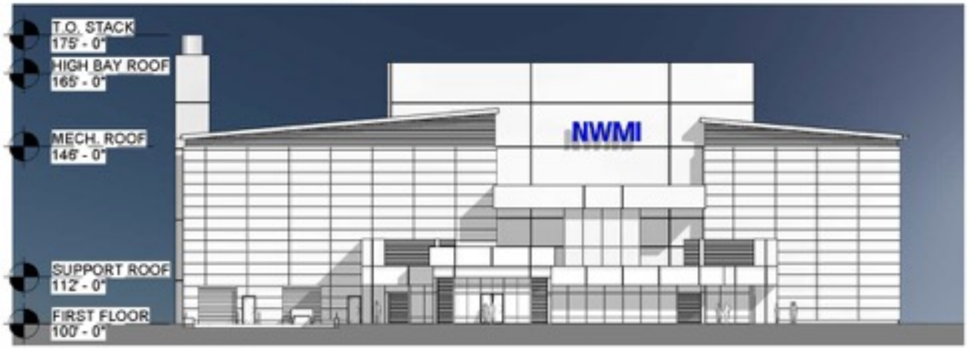


Facility Cross-Sections



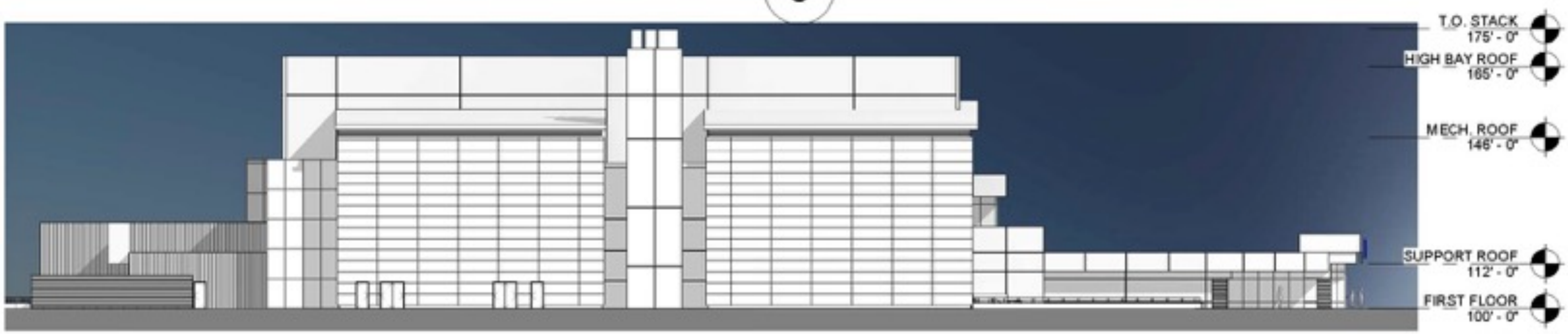
Facility Cross-Sections

1 East Elevation



2 South Elevation

3 North Elevation



4 West Elevation

Chapter 4 Questions?

Advisory Committee on Reactor Safeguards
Meeting on Northwest Medical Isotopes Construction Permit Application

Chapter 4
Facility Description

U.S. Nuclear Regulatory Commission
June 19, 2017

Introductions

- **Michael Balazik** - Project Manager, Research and Test Reactors Licensing Branch, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation

- **David Tiktinsky** - Senior Project Manager, Fuel Manufacturing Branch, Division of Fuel Cycle Safety, Safeguards, and Environmental Review, Office of Nuclear Material Safety and Safeguards

- **Alexander Adams, Jr.** - Chief, Research and Test Reactors Licensing Branch, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation

Facility Descriptions

- Addresses the primary operations at the radioisotope production facility (RPF), the description of the RPF, design descriptions, and biological shield and processes involving special nuclear material (SNM)

- The design description includes the design basis, equipment design, process control strategy, hazards identification and items relied upon for safety

Facility Descriptions

- Facility processes are described
  - Target fabrication/scrap recovery (not reviewed as part of 10 CFR Part 50 construction permit)
  - Target receipt, disassembly, and dissolution
  - Molybdenum recovery and purification
  - Uranium recovery and recycle

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements
  - 10 CFR 50.34, "Contents of applications; technical information," paragraph (a), "Preliminary safety analysis report."
  - 10 CFR 50.35, "Issuance of construction permits."
- Acceptance Criteria
  - NUREG-1537 and ISG, Part 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria."

Areas of Review

- Processes containing SNM
- Principal safety considerations factored into design
- Items Relied on for Safety (IROFS)
- Names, amounts, and specifications (chemical and physical forms) of SNM processes that are part of the RPF process
- Byproduct materials (identity and amounts) in process solutions, extracted and purified products, and wastes
- Equipment, including materials with moderating, reflecting or other nuclear-reactive properties

Areas of Review

- Biological shield design and construction, entry and exit, radiation doses, ventilation
- Radioisotope extraction system: materials, sequence, apparatus, criticality control measures, hazardous chemicals, radiation protection
- SNM processing and storage
  - Irradiated SNM
  - Unirradiated SNM

Summary of Application

- RPF facility and process description
  - Principle safety considerations factored into the design
  - Provided description of the processes used at the RPF to extract molybdenum-99
  - Drawings and diagrams to allow a clear and general understanding of the physical RPF features and processes
  - Physical and chemical forms and inventory of SNM used in the process
  - Criticality control features designed into process systems and components
  - Raw materials, byproducts, wastes, and finished products of the RPF

Summary of Application (cont.)

- Biological shield
  - Reduce radiological dose rates and accumulated dose in occupied areas to within the limits of 10 CFR Part 20
  - Guidelines of facility ALARA (as low as is reasonably achievable) program.
  - Shield materials designed to withstand seismic and other concurrent loads while maintaining containment and shielding during a design basis event
  - Shield design describes the functional design of the biological shield including for entry and exit of product, waste, process equipment and staff

Summary of Application (cont.)

- Extraction System
  - Irradiated target receipt
  - Irradiated target disassembly
  - Target dissolution
  - Molybdenum recovery and purification
  - Process description, physical properties, criticality controls, shielding and radiation protection

Summary of Application (cont.)

- SNM processing and storage
  - Irradiated SNM
    - Description of SNM processing, equipment, radioactive inventory, and hazardous chemicals
    - Process description provides account of SNM in normal process and the basis for equipment design
    - Molybdenum recovery and purification systems
    - Criticality control measures
    - Chemical protection provisions
    - Chemical inventory controls
  - Unirradiated SNM
    - Processing of unirradiated SNM to manufacture targets and scrap recovery was not evaluated by the NRC Staff during construction permit safety review
    - 10 CFR Part 70 application required

Review Procedures and Technical Evaluation

The staff performed an evaluation of the technical information presented in Chapter 4 of the NWMI preliminary safety analysis report (PSAR), to assess the sufficiency of the preliminary design and the description of the facility processes in support of the issuance of a construction permit.

Review Procedures and Technical Evaluation

- Biological Shield
- Extraction System
- Processing of Irradiated SNM

Evaluation Findings and Conclusions

- PSAR Chapter 4 provides general understanding of processes
- Biological shield analysis offers reasonable assurance that design will limit radiation exposures to within 10 CFR Part 20 limits and ALARA considerations
- Molybdenum-99 extraction and purification system descriptions provide confidence that SNM and byproduct materials can be controlled
- Irradiated SNM processes can be operated safely

Evaluation Findings and Conclusions

- Accordingly, NWMI has met the following requirements of 10 CFR 50.35 for issuance of a construction permit:

    1) Radioisotope production facility systems have been described, including the principal architectural and engineering criteria

    2) Reasonable assurance, based on Chapter 4 review, that the proposed facility can be constructed and operated without undue risk to the health and safety of the public

U.S. Nuclear Regulatory Commission
ACRS Subcommittee Review

Chapter 5 – Coolant Systems

June 19, 2017

Strategy

- For RPF, cooling water systems are used to control temperature of process solutions from process activities and heat load resulting from radioactive decay of fission product inventory
  - Analysis was provided shows that auxiliary cooling is not needed for safety
    - Evaluated impact of overcooling process solutions
    - Evaluated impact on Gas Management System
- Chilled water is used as primary cooling fluid to process vessels
  - A central process chilled-water loop is used to cool three secondary loops:
    1. Large geometry secondary loop in hot cell
    2. Criticality-safe geometry secondary loop in hot cell
    3. Criticality-safe geometry secondary loop in target fabrication area
  - Selected gas treatment unit operations require cooling at < freezing point of water → Demands are met with water-cooled refrigerant chiller packages, cooled by secondary chilled water loops

Technical Approach

- Variation of heat generation with decay time for an individual average target irradiated at MURR and OSTR
  - Due to location of RPF relative to University reactors, minimum decay time for receipt of targets after end of irradiation (EOI)
    - MURR – ~8 hours
    - OSTR – ~48 hours
  - Combination of reactor source and minimum decay time produces an estimated individual target heat load for MURR and OSTR irradiated targets, respectively.
- Estimated maximum vessel heat load, temperature and pressure
  - Vessel with cooling jackets
  - Vessels without cooling jackets
- Only radial heat flow considered
- Model vessels as "unvented"
- Analysis Inputs
  - MURR target heat load
  - Conservative U concentration
  - Various vessel diameters

Heat Load and Thermal Flux

- Volumetric heat load contained by process vessels varies throughout RPF system as radioisotopes decay, selected radioisotopes are separated, and solution compositions are adjusted by each unit operations
- Conservatism is included in thermal flux estimate by assuming heat transfer is limited to a radial direction and neglecting heat loss from solution evaporation
  - Equivalent to modeling each vessel as an unvented vessel, even though most vessels will be either open containers or vented by vessel vent system
  - High-dose waste disposal container and irradiated target in cask at receipt represent only two process conditions listed that are closed containers
- Estimates of volumetric heat load and radial thermal flux at containment apparatus wall for selected vessels where cooling water is and is not used to control process solution temperature for various decay times

RPF Thermal Characteristics – Range of Vessels

Process location	Description
Vessels Equipped with Water-Cooling Jackets	
Dissolver 1/2 (DS-D-100/200) – Start of dissolution cycle	Dissolver vessel after insertion of dissolver basket. This configuration is included for completeness, but is not yet analyzed. Requires consideration of dissolver basket both before and after process solution added to dissolver containing a dissolver basket.
Dissolver 1/2 (DS-D-100/200) – End of dissolution cycle	Dissolver solution after dissolution complete, prior to combination with transfer flush water. Assumes Kr/Xe and I isotopes transfer to dissolver offgas equipment during dissolution.
Mo system feed tank 1A/1B (MR-TK-100/140)	Dissolver solution after transfer to Mo system feed vessel, but prior to combination with transfer flush water.
Impure uranium collection tanks (e.g., UR-TK-100A/B) – Input from Mo recovery	Process solution after recovery of Mo isotopes from uranium-bearing process solution.
Impure uranium collection tanks (e.g., UR-TK-100A/B) – Output to uranium recovery	Uranium-bearing process solution input to uranium recovery after 3 weeks of decay storage.
Ion exchange feed tank 1 (UR-TK-200)	Process solution feed to first-cycle uranium ion exchange columns after composition adjustment for ion exchange feed.
High-dose waste concentrate collection tank (WH-TK-240)	Accumulated high-dose liquid waste after concentration by waste handling system concentrator.
Vessels without Water-Cooling Jackets	
Uranium decay tank (e.g., UR-TK-700A) – Input from separation	Uranium-bearing process solution after separation of uranium from other isotopes.
Uranium decay tank (e.g., UR-TK-700A) – Output to target fabrication	Uranium bearing process solution after separation of uranium from other isotopes and 13 weeks additional decay storage.
Solid Transfer Containers (No Cooling Jackets)	
High-dose waste disposal container	High-dose waste concentrate after addition of solidification agent.
Irradiated target in cask at receipt	UO_2 in annular target cladding on receipt in transfer cask. Flux based on both internal and external surfaces. Temperature not yet evaluated.
Dissolver basket in air	UO_2 in dissolver basket for transfer between target disassembly and target dissolver. Annular configuration between basket wall and lifting post. Flux based on external surface only.

Maximum Vessel Temperature and Pressure

- Vessel temperature estimates were obtained using an overall heat transfer coefficient obtained from handbook values for a tank on legs containing water and an assumed cell air temperature of 35°C (95°F)
- Temperatures were estimated assuming no water-cooling system is active, and pressures are estimated assuming each vessel is unvented to approximate maximum values
- Vapor pressure of water at estimated vessel temperature was used to approximate maximum pressure
- Estimates were developed for maximum temperature and pressure predicted for selected vessels where cooling water is and is not used to control process solution temperature

Potential Impacts to Coolant Systems

- Overcool of Process Systems
  - Overcooling of U-bearing process solutions has potential to precipitate solids
  - Precipitation of U as a solid effectively increases U concentration of material contained in a process vessel may results in nuclear criticality
  - Impact of U precipitation upset conditions on nuclear criticality calculations were evaluated by interspersing selected tanks among vessels containing U at a conservative nominal process concentration
  - ***Summary:*** Precipitation upset conditions of U-bearing process solutions are predicted to remain below upper subcritical limit → Thus, overcooling process solutions is not predicted to pose a nuclear criticality hazard
- Gas Management System
  - Coolant system operation has potential to impact performance of gas management system cooled sections
  - Primary gas management system cooled section controls decay time provided for noble gases (isotopes of Kr and Xe) by holdup in dissolver offgas system
  - Dose consequences from a bounding release of Kr and Xe isotopes alone is < 0.15 rem
  - Bounding release of noble gases is less than 10 CFR 70.61, Performance Requirements
  - ***Summary:*** Cooling water system is not considered to be an IROFS based on potential impact of gas management systems

Conclusions

- Maximum temperature and pressure in vessels without cooling and ventilation are estimated well below pressure rating of stainless steel pipes (725 to 1500 lb/in^2, gauge)
- Impact of uranium precipitation upset conditions on nuclear criticality calculations was evaluated
- Results indicate that precipitation upset conditions U-bearing solution have been predicted to remain below an upper subcritical limit for all configurations evaluated → Overcooling process solutions is not predicted to pose a nuclear criticality hazard for current equipment configuration
- Bounding releases for Kr and Xe and dose equivalent are well below Part 70.61, "Performance Requirements" (10 CFR 70.61) (Chapter 19) → Cooling water system is not considered to be an IROFS based on potential impact of gas management systems

Chapter 5 Questions?

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Advisory Committee on Reactor Safeguards
Meeting on Northwest Medical Isotopes Construction Permit Application

Chapter 5
Cooling Systems

U.S. Nuclear Regulatory Commission
June 19, 2017

Introductions

- **Michael Balazik** - Project Manager, Research and Test Reactors Licensing Branch, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation

- **Alexander Adams, Jr.** - Chief, Research and Test Reactors Licensing Branch, Division of Policy and Rulemaking, Office of Nuclear Reactor Regulation

- **James Servatius** - Technical Reviewer, Information Systems Laboratories, Inc.

RPF Cooling Systems

- Principal purpose of the cooling systems is to control the temperature of process solutions during process activities and safely remove decay heat from the target solution.

- Systems should remove and transfer heat to the environment from all significant heat sources.

- Design of the cooling systems is based on interdependent parameters.

- A central process chilled-water system cools three secondary loops, two in the hot cell and one in the target fabrication area, through plate-and-frame heat exchangers and transfers the heat through air-cooled chillers.

Regulatory Basis and Acceptance Criteria

- Regulatory Requirements
  - 10 CFR 20.1201, “Occupational dose limits for adults.”
  - 10 CFR 20.1301, “Dose limits for individual members of the public.”
  - 10 CFR 50.34, “Contents of applications; technical information,” paragraph (a), “Preliminary safety analysis report.”
  - 10 CFR 50.35, “Issuance of construction permits.”
  - 10 CFR 50.40, “Common standards.”

Regulatory Basis and Acceptance Criteria (cont.)

- Acceptance Criteria
  - NUREG-1537, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria” and ISG augmenting NUREG-1537, Part 2.

Areas of Review

- The staff performed a thorough and complete section-by-section evaluation of the technical information presented in Chapter 5 of the NWMI PSAR, as supplemented by responses to RAIs, to assess the sufficiency of the preliminary design and performance of NWMI's cooling systems in support of the issuance of a construction permit.

- Staff considered design criteria, design bases, and relevant design information to provide reasonable assurance that the final design will conform to the design basis.

- Areas of review included irradiated target basis, vessels considered for thermal characterization, heat load and thermal flux, maximum vessel temperature and pressure estimates, potential impact of overcooling process solutions, and potential impact on the gas management system.

Summary of Application

- NWMI PSAR Chapter 5 provides the preliminary design of the NWMI RPF cooling systems, including physical descriptions, design bases, and process functions and operation.

- The preliminary design of the cooling systems is supported by figures, that show flow paths of the chilled-water system, tables, that describe heat load of water-cooled vessels, and documents that describe supporting detailed calculations.

- Since the RPF is at a separate site, independent from the reactors used to irradiate the targets, the RPF does not have or need a primary or secondary cooling system. The RPF cooling systems are considered auxiliary systems and not IROFS.

Review of Production Facility Cooling System

- NWMI PSAR, Section 5.1.1, discusses an irradiated target heat load of less than 200 watts based on targets irradiated at University of Missouri Research Reactor (MURR) and an 8-hour minimum decay time for receipt of MURR irradiated targets.
- NWMI states that at-reactor handling procedures are projected to require significantly longer than 8 hours for an irradiated target and that the clock time is recorded on transfer papers and the target will not be unloaded before 8 hours has elapsed.

Review of Production Facility Cooling System (cont.)

- NWMI PSAR, Section 5.1.1 discusses the design basis for evaluating the need for auxiliary cooling that assumes processing 8 MURR targets per week while the RPF facility design basis assumes a processing capability of 12 MURR targets per week.

- NWMI states that the design basis for evaluating the need for auxiliary cooling will be changed to 12 MURR targets per week and that supporting calculations will be updated accordingly. The design basis change is not expected to impact the thermal analysis of vessel temperature since the uranium concentration and radial thermal flux will not change.

Review of Production Facility Cooling System (cont.)

- NWMI PSAR, Section 5.1.2, discusses three groups of vessels selected to describe RPF thermal characteristics. The staff determined that the selection of vessels for thermal characterization demonstrates an adequate design basis for the chilled water system and is sufficient for satisfying the standards for issuance of a construction permit.

- NWMI PSAR, Section 5.1.3, discusses heat load and thermal flux for supporting the preliminary design of the chilled water system. Thermal flux is based on simple, steady-state, radial heat transfer neglecting axial heat flow and evaporative heat losses. The staff determined that the heat load and thermal flux calculations demonstrate an adequate design basis for the NWMI chilled water system and is sufficient for satisfying the standards for issuance of a construction permit.

Review of Production Facility Cooling System (cont.)

- NWMI PSAR, Section 5.1.4, discusses maximum vessel temperature and pressure estimates for supporting the preliminary design of the chilled water system. Vessel temperatures assume no water cooling and pressures assume vessels are not vented. The staff determined that the maximum temperature and pressure calculations demonstrate an adequate design basis for the chilled water system and are sufficient for satisfying the standards for issuance of a construction permit.

Review of Production Facility Cooling System (cont.)

- NWMI PSAR, Section 5.1.5, discusses the potential impact of overcooling process solutions for supporting the preliminary design of the chilled water system. The impact of uranium precipitation upset conditions on nuclear criticality was evaluated by interspersing a specified uranium concentration among vessels containing uranium at a nominal process concentration. The staff determined that the precipitation upset calculations demonstrate an adequate design basis for the preliminary design for the chilled water system and are sufficient for satisfying the standards for issuance of a construction permit

Review of Production Facility Cooling System (cont.)

- NWMI PSAR, Section 5.1.6, discusses the potential impact of the chilled water system on the gas management system for supporting the preliminary design of the chilled water system. The staff determined that the level of detail in the calculations demonstrate an adequate design basis for the chilled water system and is sufficient for satisfying the standards for issuance of a construction permit.

Evaluation Findings and Conclusions

- The staff finds that the level of detail provided on the cooling systems is suitable to determine that, with respect to these systems:

    1) The RPF is designed to operate with a minimal heat load during normal operation.

    2) Since the RPF is independent of the irradiation facility, there is no long-lived fission product buildup in the irradiated targets.

Evaluation Findings and Conclusions (cont.)

3) NWMI has stated that the maximum temperature and pressure within RPF vessels are anticipated to not result in failure of a process apparatus; therefore, the cooling water system is not selected as an IROFS. While this statement must be substantiated by calculations in the final design, the design of the cooling system as documented in the PSAR is sufficient for satisfying the standards for issuance of a construction permit.

4) Based on engineering judgment, the staff concludes that this level of detail on the cooling system is adequate for the issuance of a construction permit because there is low heat load, and therefore there is little or no safety risk.

Evaluation Findings and Conclusions (cont.)

- Accordingly, NWMI has met the following requirements of 10 CFR 50.35 for issuance of a construction permit, with respect to the cooling system:
    1) Cooling systems have been described, including the principal architectural and engineering criteria for the design.
    2) Further technical or design information may be reasonably left for later consideration in the FSAR.
    3) The cooling system is not an IROFS and the major features do not need to be functional for the protection of the health and safety of the public.
    4) Reasonable assurance that the proposed facility can be constructed and operated without undue risk to the health and safety of the public.